

15,000-Mile
Road Test: **How Good Is the Tempest?**

POPULAR SCIENCE

FEBRUARY • 35c Monthly

First Turbine Fire Engine

PAGE 104

TURBINE
EXHAUST
STACK



EXTRA

DOUBLE-LENGTH
TRUE ADVENTURE
**The Violent End
of Flight 2511**

PAGE 243

BOATING SPECIAL

- Hank Bowman on What's Coming in Outboards
- New Hinged Aluminum Boat Folds Flat

"I SAW MYSELF 10 YEARS FROM NOW!"



IT WAS PAYDAY. THERE WAS FRED, LOOKING A LITTLE RUN-DOWN. ON THE SAME JOB 10 YEARS. NICE GUY. MARRIED. TWO CHILDREN.

FRED AND I WALKED AWAY FROM THE PAY WINDOW TOGETHER. HE SEEMED DEPRESSED, UNHAPPY.

EACH WEEK I FEEL I'M LETTING THE KIDS DOWN. CAN'T SEEM TO AFFORD THINGS THEY NEED. I'M JUST NOT GETTING AHEAD.



FRED'S WORDS HIT ME ALL OF A SUDDEN. I COULD SEE MYSELF SAYING THE SAME THING — **10 YEARS FROM NOW!**



THAT NIGHT, STILL THINKING ABOUT FRED, I SAW AN I.C.S. AD ABOUT HOW I.C.S. TRAINING OPENS JOB OPPORTUNITIES. HOW PEOPLE LIKE ME CAN WIN PROMOTIONS, MORE PAY.



I MAILED THE I.C.S. COUPON THAT NIGHT. MY BOSS SOON LEARNED I WAS AN I.C.S. STUDENT. HE MOVED ME OFF THE LINE. AND TWO RAISES LATER...

GEE, FRED, THESE I.C.S. COURSES ARE GREAT! YOU OUGHT TO SIGN UP, TOO!

WELL...MAYBE SOME DAY...

FRED'S STILL ON THE SAME OLD JOB. STILL HOPING FOR THE "BREAK" HE'LL NEVER GET WITHOUT TRAINING. ONE DAY THE BOSS CALLED ME IN...

YOU'RE BEING PROMOTED TO ASSISTANT SUPERVISOR. AND A GOOD RAISE GOES WITH THE JOB!

THANKS TO THOSE PRACTICAL I.C.S. COURSES!

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Country cousin: *It thrives on the rugged life. P. 67*

Funny money: *Are they unfair to do-it-yourselfers? P. 99*

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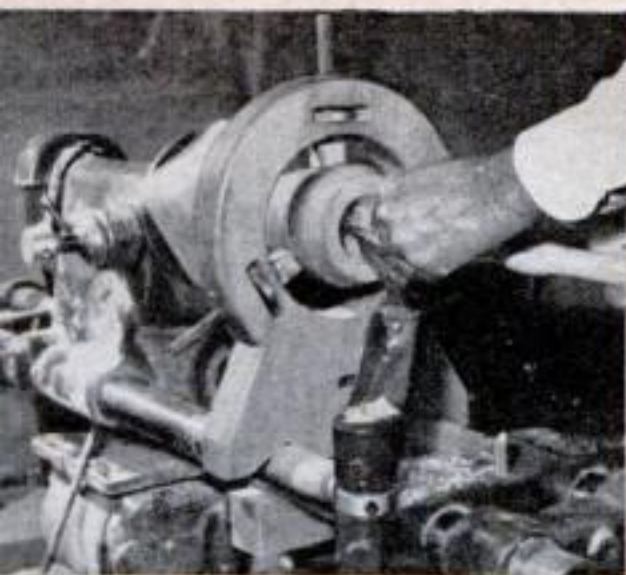
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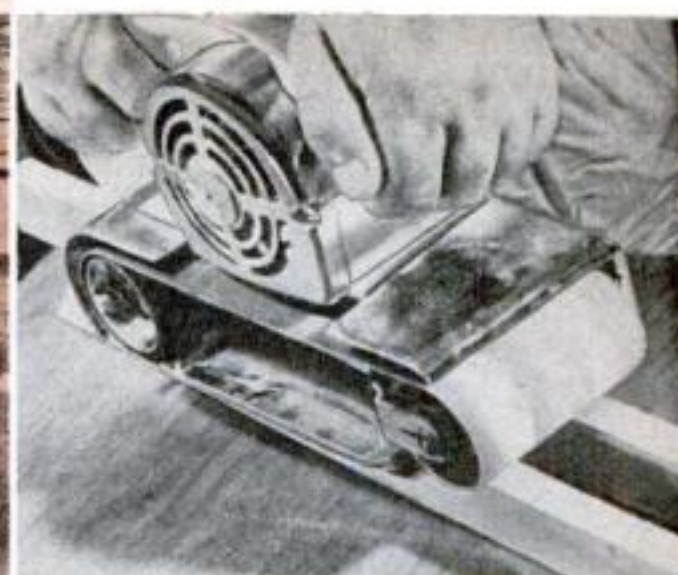
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Folding boat: Hinges let it flatten like a flapjack. P. 133



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PS Readers



TALK BACK

Hanger Saws and Hoo-Hoo Things

"THE Folk Toys We're All Forgetting" [Dec.] was delightful reminiscence. But I want to quarrel with the thesis that folk toys are a lost art. My theory is that these simple playthings are invented, forgotten, and reinvented as the raw materials for making them become more or less available.

How's a boy to make a wooden whistle these days? If he goes out to hack a branch off a willow, he'll be in trouble with tree-worshiping gardeners, if not with the cops. And wooden package handles are going the way of the wooden cigar box.

Yet Yankee ingenuity still flourishes. My own son invented some marvelously simple folk toys. One is the Hoo-Hoo Thing: the tubular cardboard core from a roll of toilet paper or kitchen towels. It makes an excellent megaphone, admirably suited to calling "Hoo-o-o-o hoo-o-o-o" through.

Even better is his Hanger Saw. This is just the cardboard strip that pads the trouser bar of a wire coat hanger. Many of these strips have saw-tooth edges and make a most satisfying buzz when pulled across furniture legs (which are just standing there demanding to be sawed at by a four-year-old).

M. R. DWIGHT, Wellesley, Mass.

He's for Electric Heat

I WANT to tell you that you are right about electric heating ["No Flame, No Smoke, No Chimney," Nov.].

Four years ago, we built a new living room on the side of the house. We insulated it with two-inch fiber-glass with aluminum backing. We installed five baseboard heaters, or 2,500 watts. They do a beautiful job, even in subzero weather, heating that 29-by-12-foot room. The thermostat is set at 70, and when the

weather gets cold enough for the heaters to operate, the light bill shows it. Last winter it stayed below 10 degrees about two weeks, with every night below zero, and our bill was \$72. It normally runs around \$35.

In a milder climate, electric heating would be my choice. It's quiet, clean, and service-free. The rest of my house has oil heat, and I wouldn't recommend that gummy, greasy stuff to anybody. For a cold climate you can't beat gas. I have it in my store.

CLARK F. CONAWAY, Knightstown, Ind.

Tips for Drivers

A COUPLE of years ago on an 8,000-mile auto trip, I discovered a new way to stay awake: chew bubble gum. This stuff chews harder than regular gum and the heavy chomping keeps you alert. I don't recommend it in place of regular sleep or rest periods, or for drivers pushing too long for safety. But it's a harmless and effective method for the driver



who has just had a big meal, the night worker driving home, or the driver who becomes drowsy riding alone.

E. N. WOLFE, Kansas City, Mo.

... I CARRY about 45 pounds of air in the spare tire instead of the 28 pounds called for when the tire is in use. Also I carry a length of hose with a fitting on each end. In this way I always have air on tap should any tire get low. It has turned out to be a happy thought several times while on the road or parked in a lot a good distance from a service station.

C. N. FINN, Little Rock, Ark.

... JUST read the Model Garage Hint on how to keep down corrosion on bat-

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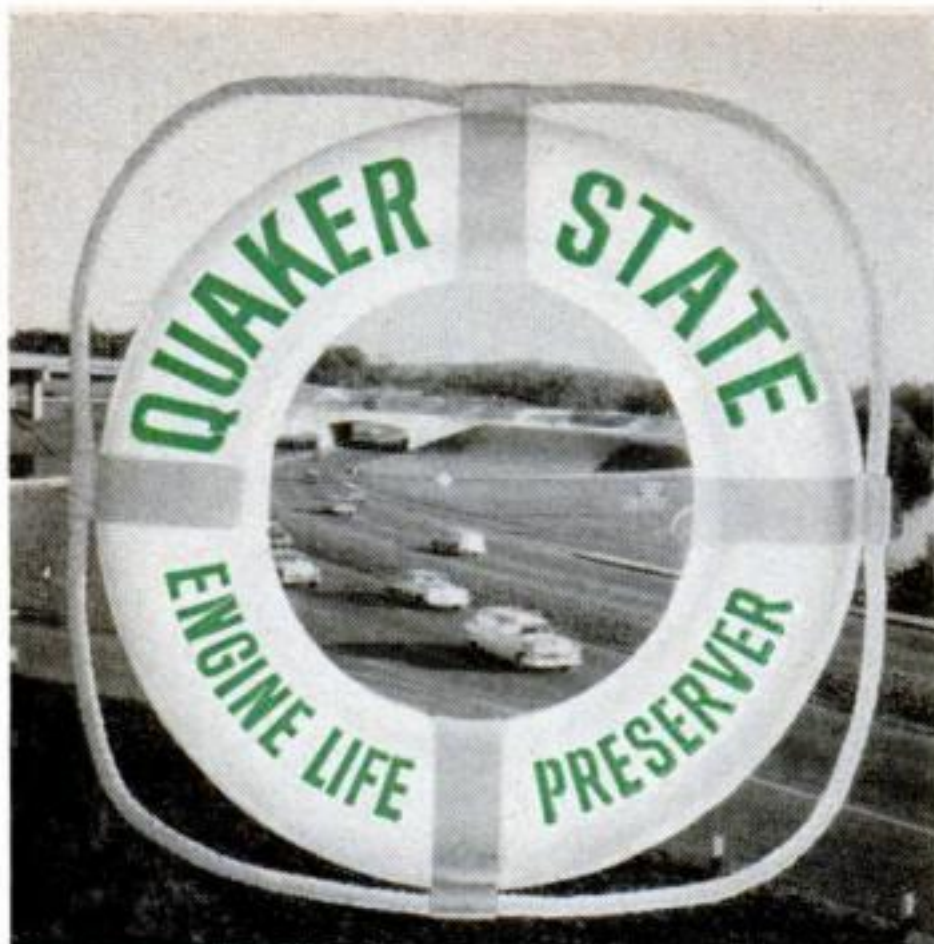
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tery terminals [Dec.], but I still like my way best:

I cut two felt washers from an old felt hat and put one on each of the posts under the clamp. The washers should be at least 2" in diameter to allow for cutting the hole in the center. When the car is serviced, I put a few drops of oil on each of the pads and there is never any corrosion on the terminals. The battery man that told me of this showed me the clamps on his Nash car and told me they were the original ones—16 years old. I have done this for a number of years and never have had to put new clamps on the cables.

ALBERT B. JOHNSON, Marysville, Kan.

Are Smoke Screens Old Hat?

THE smoke-screened getaway car rigged by that jewel thief the FBI caught ["Picture News," Dec., p. 103] is a rarity now, but used to be standard equipment for bootleggers in the Twenties.

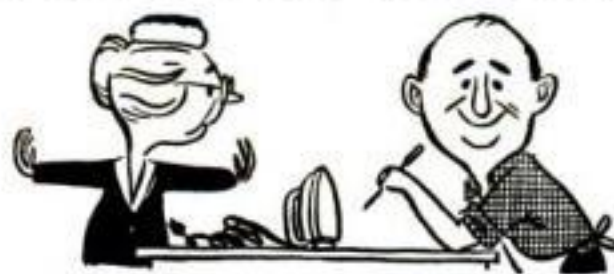
Today moonshine transporters consider smoke unsporting—it might cause the pursuing revenooers to lose control. And hurting cops is bad for business.

A. L. CAPE, Marietta, Ga.

Fun and Games for a Living

THE customers in my electric-appliance repair shop certainly keep life from getting dull. Recently, an elderly lady made my day.

She popped in with an equally elderly electric iron that blew a fuse every time



she tried to use it. After testing her iron, I informed her that it was badly short-circuited. She puzzled over this for a while, then asked timidly: "Can you lengthen it while I wait?"

CARNEY CHESS, N. Hollywood, Calif.

Shades of Annie Oakley

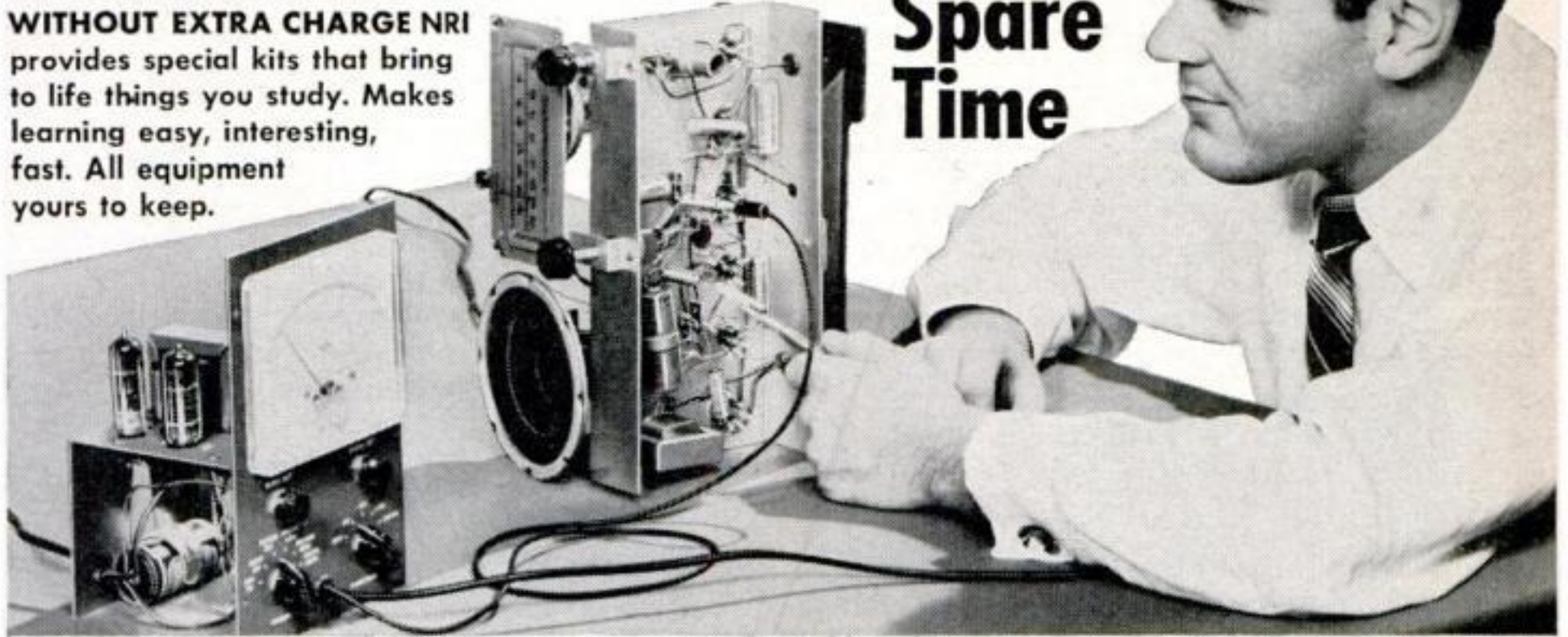
MY WIFE brought an old-fashioned earthenware cookie jar out to my shop and asked me if I could bore a hole in its bottom so she could use it for a flowerpot. I have bored lots of holes in concrete and masonry with a masonry drill, but never one in the bottom of an

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J. M. SMITH
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NRI Trained These Men



I was working in a textile factory trying to make ends meet. Now I own one of the most modern service shops in this section. **ARGIE C. TAYLOR**, Glasgow, Ky.

After graduating I was a shipboard radio operator. Now I am chief engineer at Station WARA.



NRI was a wonderful foundation. **RAYMOND D. ARNOLD**, Attleboro, Mass.

Thanks to NRI I am in a top position with the Federal Aviation Agency in the Navoids Electronic Section. **JOE DUCKWORTH**, Fort Worth, Texas.

Four months after starting your course I left my job in a hardware store to work at Raytheon Manufacturing. Now I am an engineering assistant in Microwave Power Tube Research and Development Laboratory. **LEONARD BLOOM**, Newton Centre, Mass.



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old cookie jar. Well, sir, I surprised myself.

I didn't have a drill in the shop, masonry or high speed, that would make more than a small indentation in the blasted jar; but I wasn't about to give up even if my experimentations broke it in a thousand pieces. Here's what I did:

I packed the jar with damp sand, level with the top, turned the jar upside down, aimed my .22-cal. rifle at the middle of



the bottom of the jar, and pulled the trigger. Result: a dandy hole.

PHILIP J. SHULER, Acton, Calif.

Pity the Poor Proofreader

AFTER reading your December Puzzlers, I have a puzzler for you: That plum bob you mentioned [p. 45]—is that what you set up at a Halloween party when you run out of apples?

BOB SYLVESTER, St. Paul, Minn.

Only a few thousand copies of the magazine spelled plumb bob without the familiar b at the end. Before the printing run was well started, an alert editor spotted the missing letter. Nevertheless, plumb bob or plum bob, it means the same thing and you'll find both spellings in Webster's New International (Unabridged) Dictionary.

Cider Press Ferments Words

IT SEEMS to me that the hard-cider maker pictured in November ["The Rig to Make Hard Cider"] is a little mixed on arithmetic and pounds per square inch. He says to suit the press for the jack you'll use, and aim for a rig that will put about 150 p.s.i. on the press rack.

The drawings show a press rack having an area of about 80 square inches. Under the pressure recommended, this would require the jack to develop a thrust of 12,000 pounds (six tons).

The picture shows a conventional bumper jack in use. These usually have a rated capacity of 2,500 to 3,000 pounds, or 1¼ to 1½ tons, which is probably a generous rating.



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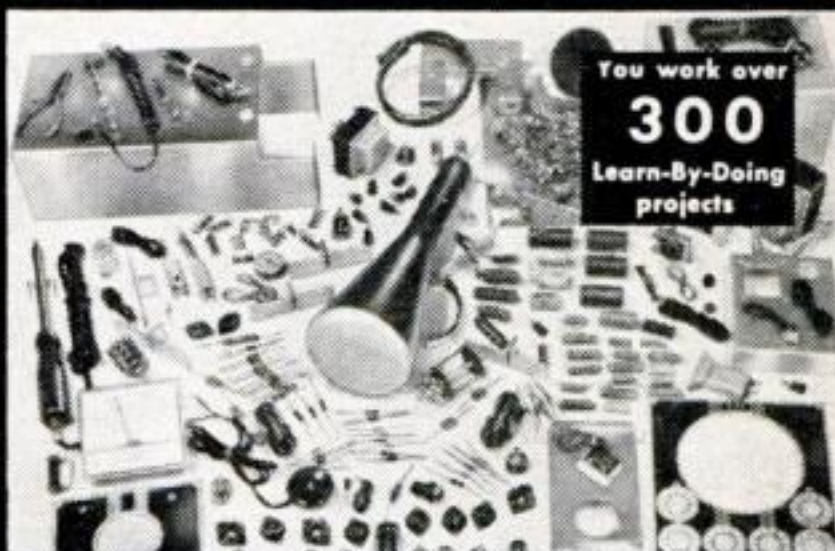
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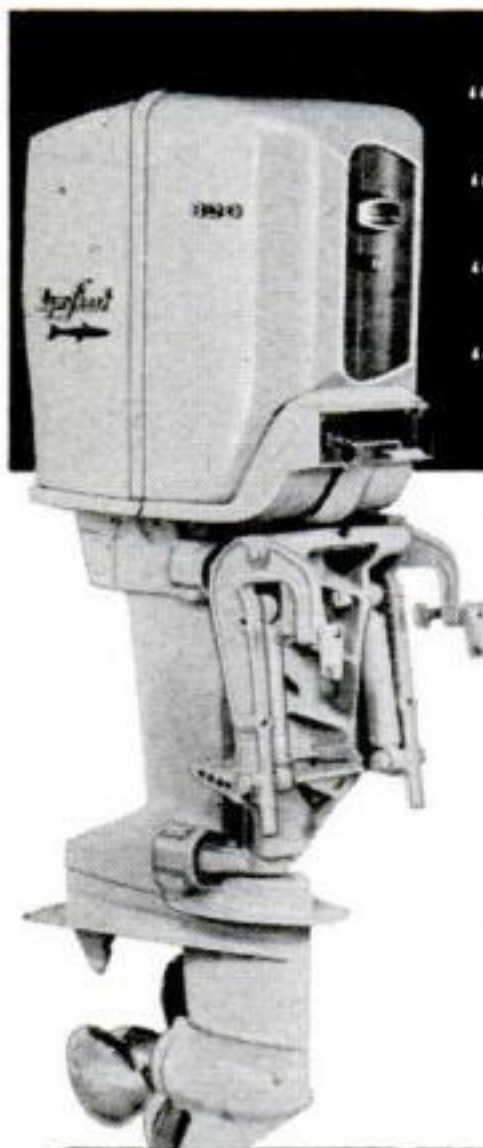
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He doesn't seem to be exerting himself very much, yet he'd have to, to produce even 6,000 pounds pressure. Does his phenomenal power come from exuberance developed by liberal draughts of his high-power cider, or did he arrive at the 150 p.s.i. figure while in a foggy mood induced in a similar way? Whichever way it came about, it gives support to his statement, and conclusion, that stuff like that is illegal.

ELWOOD J. WAY, Washington, D.C.

The author, E. F. Lindsley, replies: "The letter from Mr. Way only goes to show that the inner secrets of what is essentially an 'art' should never be revealed to a certain type of mind. I suspect, from his address, that he works for the alcohol-tax people and I'm inclined to take the fifth (amendment, that is).

"For the record, the press rack is made of 10 strips of one-by-ten, five of which make up slightly less than 50 square inches on which we compute unit loading. At 150 p.s.i., which we are 'aiming' at, and I use the term loosely, we would need only 7,500 pounds.

"Bumper jacks are rated for safety. Here, this is no concern and I hang and bounce on the jack handle far harder than I've ever done when hoisting a car. I may not hit 150 p.s.i., but let E. J. Way prove I don't come close to it on the unit loading of the rack slats. What's more, if he's one of those government fellows, he'd better keep away from our pressing parties in these parts."

. . . MAY we have permission to reproduce the article on the cider-making rig? We'd like to distribute it to a few of our



apple customers. Several have already purchased all the copies on the newsstands here and we'd like to supply about 50 more who are interested.

E. C. CLAPPER, Cut Bank, Mont.

Why sure. Looks like the folks in Cut Bank are going to have a Big Time.

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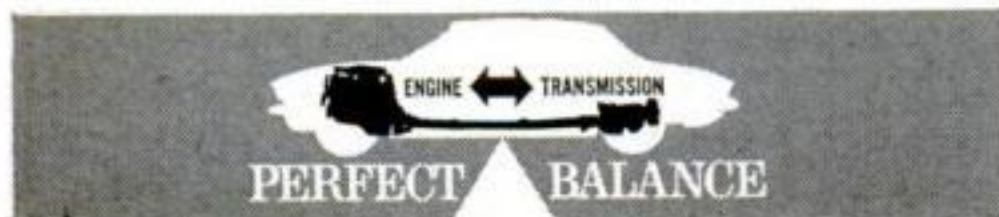
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RUGGED RELIABILITY TEST: NEW TEMPEST DRIVEN ROUGH AND HARD BY TEAM OF TEENAGERS!



Six of the teenagers photographed at a rest stop in Denver, Colorado. Left to right: Roger Anthony, John Sheffler, Jay Hall, Larry Weber, Jim Bader and Bob Quaid.

THE HOT TOPIC IS THE NEW TEMPEST BY PONTIAC!



When you turn a couple of new cars over to a team of teenagers, you know the cars will get a real test of performance and durability. That's exactly what Pontiac did last July 1 with a Tempest Sedan and a Tempest Safari! The only instructions: "Keep them moving 24 hours a day. Treat them rough! Pile on the miles! Drive safely. Stick to the traffic laws."

The Tempest had already passed all the usual car tests (2,600,000 miles of testing by pro drivers and engineers). But this was the big one. A new and different kind of test. Pass this and the Tempest had it made.

It was a responsible assignment. The kids knew it and they bought it—100%! Sure they got tough with the cars. But that's what Pontiac expected—and wanted! That's the way you find out how much a car can take . . . how much it can deliver.

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The test ended on October 15, 1960. The durability run proved conclusively that the new Tempest (with the 4-cylinder engine up front . . . transmission in the rear . . . flexible, triple-alloy steel drive shaft . . . 4-wheel independent suspension . . . integral body and frame) gives the others something to shoot for on performance, economy and reliability.

THROUGH 48 STATES, CANADA, TOO!

Supervised by three Pontiac engineers, these teenagers really man-handled the Tempest through 48 states and 7 Canadian provinces. They rammed the cars over back roads! Held it at the legal limit on expressways! Breezed it up and down Pikes Peak with no sweat! Scooted across scorching deserts.

EQUAL TO SEVEN YEARS OF DRIVING

Day and night the miles piled up. 100,947 on the Sedan; 101,002 on the Wagon. Roughly the same as 7 or 8 years' driving. The cars got no special care. The protective maintenance procedures recommended in the Owner's Manual were followed—and it paid off! Plugs, points and fuel filters were changed every 12 to 15 thousand miles. Brakes were adjusted a couple of times but *never needed relining!* Tires were changed twice.

(Here are the other repairs. Sedan: 19,194 miles—starter solenoid changed. 20,701 miles—windshield cracked by stone. 40,094—left rear back-up light replaced. 62,765 miles—fuel pump replaced. 96,492—generator brushes replaced. 98,549—radiator leak repaired. Wagon: 4,576—light switch replaced. 16,192—stone chip in windshield. 40,591—heater switch connector loose. 51,368 miles—flying rock pierced gas tank. 96,527—generator brushes replaced. 97,210—rear wheel bearing replaced.)

That's it! And that's low-cost, trouble-free driving. Check the Tempest out yourself! See your Pontiac dealer. Get the keys. Drive it.

PONTIAC MOTOR DIVISION • GENERAL MOTORS CORPORATION



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101,002 TOUGH
MILES!
IN 107 DAY ROUND-THE-CLOCK MARATHON



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NRI Sends Tester to Learn and Earn

You need proper equipment to service today's automatic appliances. With this course you get parts to build professional type, multi-use Appliance Tester. You learn to use it. Takes guess work out of servicing. Mail coupon for FREE book and Sample Lesson. See how easy it is to learn. Find out about NRI—a school that for more than 40 years has been training men, through home study, for success, good pay jobs. Our reputation, record, experience back up this course. Write now to: National Radio Institute, Dept. BB1, Washington 16, D. C.



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"I call it a bad day if I don't make \$25 before noon"

(This chair alone brought \$4.50 with twenty-five minutes work and 32¢ in cleaning materials.)

"Just a few months ago I made the big move. I gave up my job and started spending all my time in the little business I had been running on the side. It wasn't an easy decision, but, now I'm tickled to death I made it. Not just because I'm my own boss or because I have an excellent chance of making over \$10,000 this year. It goes deeper than that.

"You see, this idea has caught on like wildfire in my town. Not a day goes by without my phone ringing with women calling for appointments. The beauty of it is that once a woman becomes my customer, she calls back year after year. Not only that, she tells her friends, too, and they call me. Before I know it I'm swamped with work. (And at \$7.50 an hour net profit it doesn't take long before my bank account is really mushrooming.)

"Funny thing, but back last year, before I started, I never realized the money there was in this business waiting for someone to come along and collect it. Just think: every house in town has furniture and most have rugs or carpeting. I concentrate on just the better homes and have more work than I can handle. You know why? Because women are fussy about their furnishings. Can't stand to see them dirty. That's why they call me over every year.

"The average job is worth \$25.00 to me and takes a little over 2 hours. Out of this, after paying for materials, advertising and other expenses I net about \$15.00 clear profit. This means I need just 3 jobs a day to clear \$11,250.00 in a year. Frankly, since this will be my first full-time year I'll be glad to hit the \$10,000 mark. But after that this business should grow larger each year until I have to hire men to help me handle the business.

Personally Trained

"Believe me there's nothing magic about it. I didn't know a thing about cleaning home furnishings before I became a Duraclean dealer. But after my application was accepted, I was trained in their factory-training school and by a dealer in a nearby town. I was astonished by the short time it took me to become an expert. Actually, much of the credit must go to the Duraclean process, which is so safe it has earned the Parents' Magazine Seal.

"The portable machine you see is just one of the electrical machines I use. It manufactures a light aerated foam with a peculiar action chemist call 'peptizing'. It means that instead of being scrubbed deep into the fabric, dirt is gently **ABSORBED** by the foam, leaving the fabric clean all the way down. Women can't believe their eyes when they see how it works. Colors appear bright again, and rug pile unmats and rises like new. I don't have to soak rugs or upholstery to get them clean, which ends the problem of shrinkage, and means the furnishings can be used again the very same day. This alone has brought me a lot of customers.

"As a Duraclean dealer I make money with four other services, too: **Duraproof** . . . which makes furnishings immune to moth and carpet beetle damage (it's backed by a six year warranty). **Durashield**, a brand new dirt-delaying treatment. It coats fabrics with an invisible film that keeps dirt out. **Duraguard**, another new service, flameproofs draperies, upholstery and carpets to reduce charring

by
**Harold
Holmes**



and the tendency of fires to flame up. And **Spotcraft**, which consists of special chemical products for removing stubborn spots and stains. On jobs where I perform all five services, I multiply profits!

"One of the nicest things about being a Duraclean dealer is that I get continuous help from Duraclean Headquarters. My services are nationally-advertised in famous magazines like McCall's, House Beautiful and many others. I also get a complete advertising kit prepared by experts. (There's even a musical commercial!) I get a monthly magazine full of methods to build business and I can meet with other dealers at Duraclean conventions. I'm also backed by insurance. In fact there are over 25 regular services I get under their unique System.

No Shop Needed

"Maybe you too would like to break away from your job and make a fresh start in a business of your own. Do you need a shop? Certainly not. I operate from home. Need a lot of money to start? Not at all. Duraclean finances reliable men, after a moderate down payment, and furnishes enough supplies to return your **TOTAL** investment.

"You get everything you need: equipment, supplies, advertising matter, personal training, and regular help from Headquarters. To get all the details, fill out the coupon. There's no obligation and you can *decide for yourself*. I'll say one thing: if you **DO** become a Duraclean dealer, you'll be glad the rest of your life that you took time today to write."

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PS Puzzlers

By Joan Steen

A file of fillips to foil you . . . Answers on page 210



Pigs That Didn't Go to Market

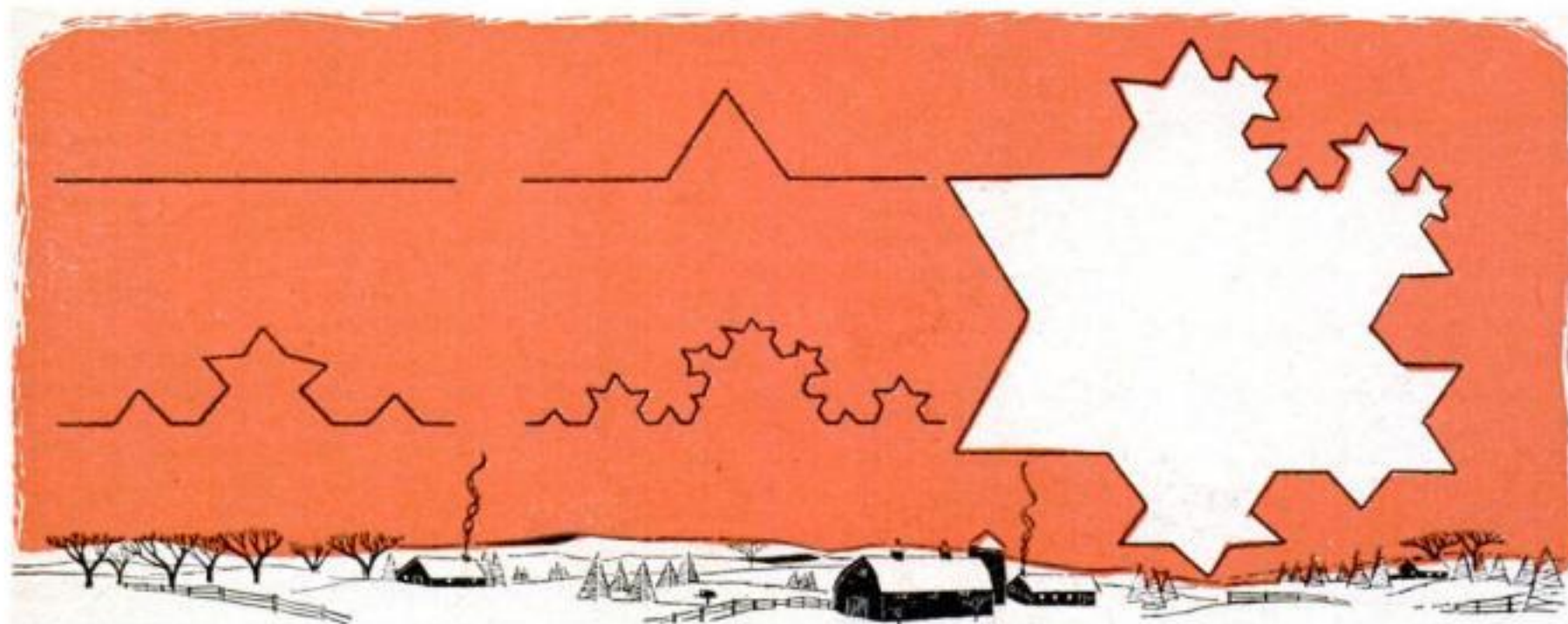
NOT pigs-in-pokes but pigs-in-corners would be a good name for this Lewis Carroll puzzle. Bearing in mind that it has a punning twist, can you house the pigs?

In the kingdom of Kgovjni is a marble square with a pig sty in each corner. Her Radiancy has decreed that 24 pigs be placed in those corners so that as she

goes round the court she always finds the number in each sty nearer to 10 than the number in the last.

"Does she call 10 nearer to 10 than 9 is?" asks a visitor.

"Surely," said the governor. Furthermore, she doesn't just go around once—but again and again—always finding the number in each sty fulfilling her decree.

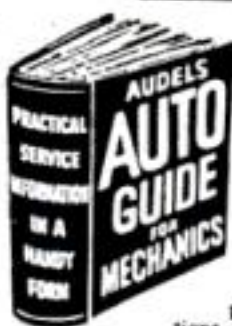


HERE'S a paradox to think about. You might call it the case of the infinite snowflake. Smugly I say I can define a continuous curve (my pencil doesn't leave the paper) on a flat surface in such a way that the whole curve could fit in a space the size of a postage stamp and yet the distance along the curve between a pair of points can be as long as—or

longer than—the distance from the earth to the sun. Out of my mind, you say? Here goes:

Start with a line segment one unit long. Take the middle third of it and on it construct an equilateral triangle. Now erase the base line. My curve is now made up of four little segments. Now take each of these segments in turn and

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PS Puzzlers

continued

construct an equilateral triangle on its middle third, again erasing the base line. Continue the process.

I say that's a well-defined method of constructing a curve whose length can be made as long as I like. (If you start with an equilateral triangle as your original figure, you get the snowflake figure shown on the previous page.) Am I right?



NO PENCILS for these quickies:

1. Three horizontal lines are an inch apart and directly under one another. Now imagine three vertical lines, also an inch apart, that cut all three horizontals. How many squares are formed?

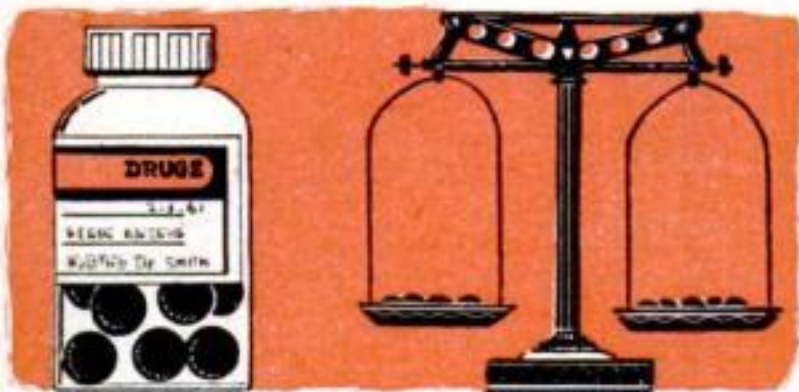
2. Where on earth can you walk north, turn left making a right angle, and find yourself facing east?

3. Uncle Harry bought a baseball and a bat. The bat cost him a quarter more than the ball. How much did each cost if together they cost \$1.25?

IS THERE a woodworker in the house? I possess an unusual complement of left hands, so I leave it to the more dexterous of you to solve this one:

Two solid pieces of wood have been neatly dovetailed as in the diagram at left. The hidden two faces show similar joints. How was it done? (Five minutes in the shop and you'll probably have it all modeled.)

Puzzle of the month



THERE'S a nice twice-told puzzle about odd-weighted balls that I'm quite fond of. For those not familiar

Answer to last month's P-O-T-M. Two travelers start at the same time, go in opposite ways around a circular railway. West's train takes 2 hours; East's 3. If trains are leaving the station in both directions every 15 minutes, how many trains did each traveler pass en route—not counting trains met at the station itself?

Eastbound trains take 180 minutes to make the loop. At the end of 15 minutes they're $1/12$ the way around, so we can think of them arranged around the circle at 30-degree intervals. Westbound trains cover $1/8$ the distance every 15 minutes so they're at 45-degree intervals.

Now think of those degrees of arc as units of distance. Then as East starts out

with it, here it is—in the macabre way one reader (himself a pharmacist) decided to tell it:

There are 12 tablets in a prescription bottle. One of them is known to contain a lethal poison. While it looks the same as the others it does have a distinguishing characteristic: It's either lighter or heavier than the others. Can you determine in three independent weighings on a balance which is the deadly pill and which way it's off weight? (Answer next month.)

he will meet a westbound train coming towards him from 45 units away. Since the westbound rate is half again as fast as the eastbound, the trains will meet when East has gone exactly 18 units, West exactly 27 units. So East will meet a westbound train every 18 units around the circle.

West on the other hand leaves the station and will meet an eastbound train coming towards him from only 30 units away. Again he goes at a rate $1\frac{1}{2}$ times as fast, so he covers 18 units, the eastbound train only 12 units when they meet. Now 18 into 360 means 20 encounters for each train—but since we don't count trains met at the station itself, the total is 19 each. East meets West after 72 minutes.



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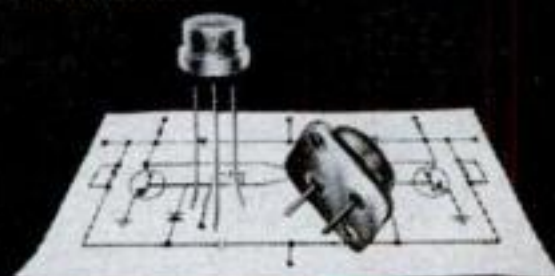
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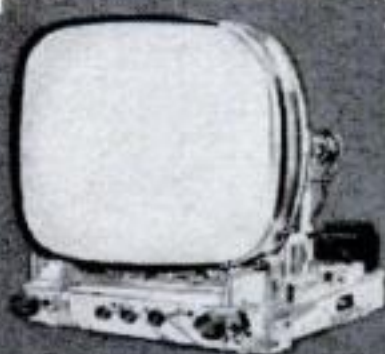
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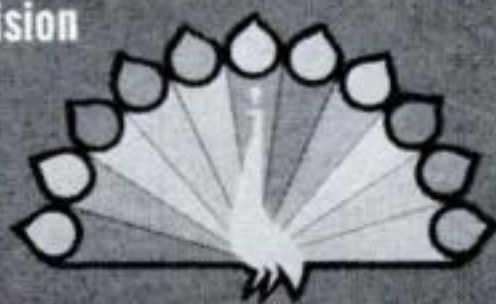
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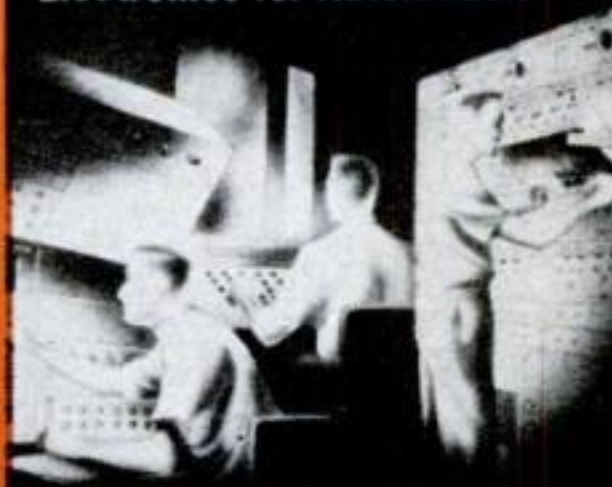
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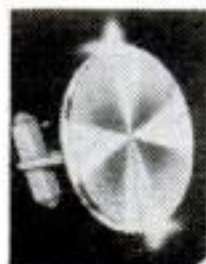
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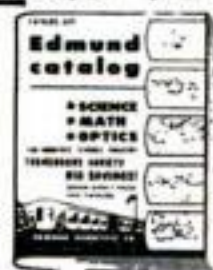
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Until now only the richest nations could afford the Deadly Gadgets. Manufacturing them has required a fabulous investment in plants to produce the necessary uranium. Pure uranium metal, as refined from the ore, contains less than one percent of the special

atoms—U-235—that will split. To make bombs, you need uranium that is 90 percent U-235. The only handle for picking the rare U-235 atoms out of the plentiful U-238 is a minute difference in weight (each U-235 atom is lighter by three neutrons).

The separation scheme adopted by the U.S. (and copied by Russia) was gaseous diffusion: The light U-235 passes through porous nickel filters more easily than the heavy U-238. The K-25 diffusion plant in Oak Ridge, Tenn., is the largest continuous-process plant in the world under one roof—a 60-acre roof. It cost one billion dollars and uses more electricity than New York City. This sort of thing, obviously, is out of Señor Castro's price range.

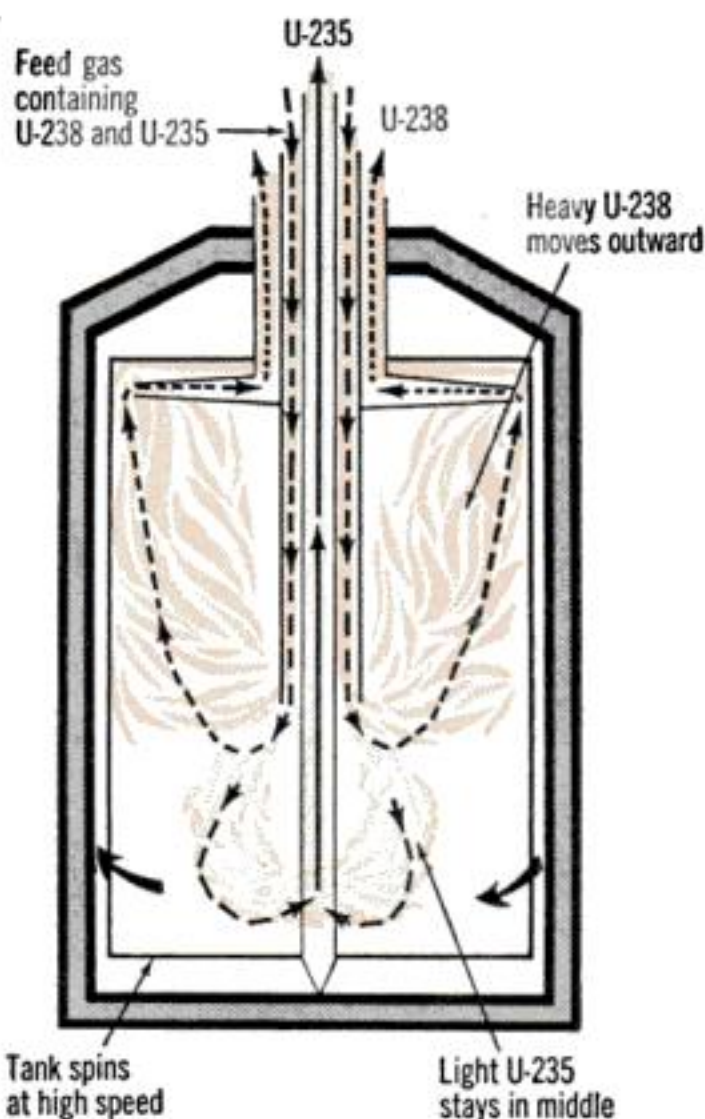
The man who broke the price on A-bomb stuff is a cosmopolitan German named Gernot Zippe. He plugged away at the gas centrifuge, an idea that the Manhattan Project tried and

dropped (it wouldn't work well with materials available in the Forties). This machine separates the uranium types by spinning them inside a fast-rotating tank. The heavy U-238 is forced to the wall of the tank—like cream in the dairy machine—while the light U-235 stays near the middle.

Zippe was interned by the Soviets, and built one centrifuge for them. When they let him go, the U.S. grabbed him to duplicate that machine here, at the University of Virginia. Then he went home to Germany and designed a really good one for the Degussa firm, of Frankfurt.

The newest centrifuges will have superstrong titanium tanks about a yard in diameter that can whirl 40,000 r.p.m. without

How "cream separator" makes atomic explosive



The month in science continued

breaking up. Such a fast spin exerts the tremendous forces needed for efficient concentration of U-235. With 50 of Zippe's machines working together in stages, you could separate 100 pounds of 90-percent U-235 in a year. That will make one bomb. A few are enough.

Apparently Degussa can manufacture such centrifuges with no more trouble than GM making Cadillacs. The price: \$5,000 each. Brazil has already bought two early models.

Using centrifuges, a few million dollars (which can always be squeezed out of the peasants) is enough to go into the A-bomb business. It would take about eight years to get rolling, thinks AEC Chairman John McCone. Unless a nuclear control plan jells before then, the weapons of total destruction may be almost as easy to come by as .30-caliber Enfields are now.

Think small (cont'd.). When Caltech's Dick Feynman urged tinkerers to try their hands at building *really* small machines (Nov. '60), he backed up his plea with cash: a \$1,000 prize to "the first guy who makes an operating electric motor which can be controlled

from the outside and is only 1/64 inch cube." Professor Feynman added, "I do not expect to wait very long for claimants." He didn't.

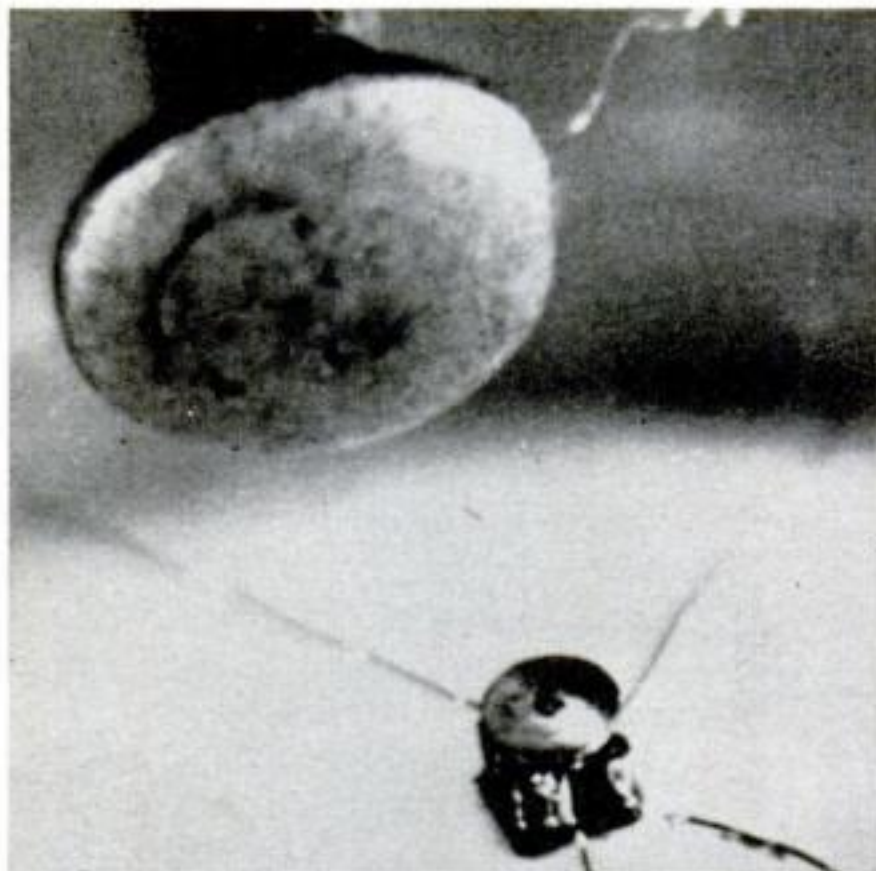
William McLellan, a young California engineer specializing in miniature parts, has now collected the prize with what is almost certainly the smallest motor ever built. It is .006 inch in diameter—smaller than the period at the end of this sentence. You have to use a microscope to see it work.

McLellan spent 2½ months of spare time making his tiny motor, using a watchmaker's lathe, a microscope, and a sharp toothpick. It draws .05 ampere and puts out all of one millionth of

a horsepower. Within its fantastically small size are crammed 13 parts, including a rotor, a quartz bearing, and four coils each wound with 21 turns of .002-inch-thick wire. There's no practical use for it (except to win the \$1,000).

Still open (at press time, anyway) is another Feynman prize: \$1,000 to "the first guy who can take the information on the page of a book and put it on an area 1/25,000 smaller in linear scale in such manner that it can be read with an electron microscope."

Scuffproof shoes. You'll get seven times the wear from shoes made of a new plastic-treated leather, coming out soon. The plastic is urethane (related to foam for cushions), also good for protecting golf balls, bowling pins, flooring, auto parts.



How small you can get: motor in front of pinhead



I'd like to give this to my fellow men...

while I am still able to help!

I was young once, as you may be—today I am older. Not too old to enjoy the fruits of my work, but older in the sense of being wiser. And once I was poor, desperately poor. Today almost any man can stretch his income to make ends meet. Today, there are few who hunger for bread and shelter. But in my youth I knew the pinch of poverty; the emptiness of hunger; the cold stare of the creditor who would not take excuses for money. Today, all that is past. And behind my city house, my

summer home, my Cadillacs, my Winter-long vacations and my sense of independence—behind all the wealth of cash and deep inner satisfaction that I enjoy—there is one simple secret. It is this secret that I would like to impart to you. If you are satisfied with a humdrum life of service to another master, turn this page now—read no more. If you are interested in a fuller life, free from bosses, free from worries, free from fears, read further. This message may be meant for you.

By Victor B. Mason

I am printing my message in a magazine. It may come to the attention of thousands of eyes. But of all those thousands, only a few will have the vision to understand. Many may read; but of a thousand only you may have the intuition, the sensitivity, to understand that what I am writing may be intended for you—may be the tide that shapes your destiny, which, taken at the crest, carries you to a level of personal independence heretofore undreamed of.

Don't misunderstand me. There is no mysticism in this. I am not speaking of occult things; of immutable laws of nature that will sweep you to success without effort on your part. That sort of talk is *rubbish!* And anyone who tries to tell you that you can *think* your way to independence without effort is a false friend. I am too much of a realist for that. And I hope you are.

I hope you are the kind of man—if you have read this far—who knows that anything worthwhile has to be *earned!* I hope you have learned that there is no reward without effort. If you have learned this, then you may be ready to take the next step in the development of your karma—you may be ready to learn and use the secret I have to impart.

I Have All The Money I Need

In my own life I have gone beyond the need of money. I have it. I have gone beyond the need of gain. I have two businesses that pay me an income well above any amount I have need for. One of these businesses is that of putting other men in business for themselves. And, I have the satisfaction—the deep satisfaction—of knowing that I have helped more than three hundred other men find independence from job worries by starting "side line" business that could be operated from the home in spare time. Since I have no need for money, the greatest satisfaction I get from life, is sharing my secret of personal independence with others—seeing them achieve the same heights of happiness that have come into my own life.

Please don't misunderstand this statement. I am not a philanthropist. Although I may help finance you in a business-like

way, I believe that charity is something that no proud man will accept. I have never seen a man who was worth his salt who would accept something for nothing. I have never met a highly successful man whom the world respected who did not sacrifice something to gain his position. And, unless you are willing to make at least part of the effort, I'm not interested in giving you a "leg up" to the achievement of your goal. Frankly, I'm going to charge you something for the information I give you. Not a lot—but enough to make me believe that you are a little above the fellows who merely "wish" for success and are not willing to sacrifice something to get it.

A Fascinating and Peculiar Business

One of the businesses in which I have helped others get a start is a peculiar one. The unusual thing about it is that the product is needed in every little community throughout this country. But it is a business that will never be invaded by the "big fellows." It has to be handled on a local basis. No giant octopus can ever gobble up the whole thing. No big combine is ever going to destroy it. It is essentially a "one man" business that can be operated without outside help. It is a business that is good summer and winter. It is a business that is growing each year. And, it is a business that can be started on an investment so small that, with my help in financing, is within the reach of anyone.

This business has another peculiarity. It can be started at home in spare time. No risk to present job. No risk to present income. And no need to let anyone else know you are "on your own." It can be run as a spare time business for extra money. Or, as it grows to the point where it is paying as much or more than your present salary, it can be expanded into a full time business—overnight. It can give you a sense of personal independence that will free you forever from the fear of lay-off, loss of job, depressions, or economic reverses.

Are You Mechanically Inclined

While the operation of this business is partly automatic, it won't run itself. If you are to use it as a stepping stone to personal independence, you must be able to work with your hands, use such tools as hammer and screw driver, and enjoy getting into a pair of blue jeans and rolling up your sleeves. But two hours a day of manual work will

keep your "factory" running 24 hours turning out a product that has a steady and ready sale in every community. A half dollar spent for raw materials can bring you six dollars in cash—six times a day—a maximum daily profit of \$33.00.

In this message I'm not going to try to tell you the entire story. There is not enough space on this page. And, I am not going to ask you to spend a penny now to learn the secret. I'll send you all the information, free. If you are interested in becoming independent, in knowing the sweet fruits of success, in becoming your own boss, send me your name. That's all. Just your name. I am not asking you for a penny at this time. I'll send you all the information about one of the most fascinating businesses you can imagine. With these facts, you will make your own investigation. You will check up on conditions in your neighborhood. You will weigh and analyze the whole proposition. Then, and then only, if you decide to take the next step, I'll allow you to invest \$15.00. And even then, if you decide that your fifteen dollars has been badly invested I'll return it to you. Don't hesitate to send your name. I have no salesmen. I will merely write you a long letter and send you complete facts about one of the businesses that has now been started by more than 300 men—and several women. After that, you make the decisions. Remember, if you decide to go ahead, I'll help you finance your start.

Does Happiness Hang on Your Decision?

Don't put this off. It may be a coincidence that you are reading these words right now. Or, it may be a matter that is more deeply connected with your destiny than either of us can say. There is only one thing certain: If you have read this far you are interested in becoming independent of jobs and bosses. And if that is true, then you must take the next step. No coupon on this advertisement. If you don't think enough of your future happiness to write your name on a postcard and mail it to me, forget the whole thing. But if you think there is a destiny that shapes men's lives, send your name now. What I send you may convince you of the truth of this proverb. And what I send you now will not cost a penny, now or ever.

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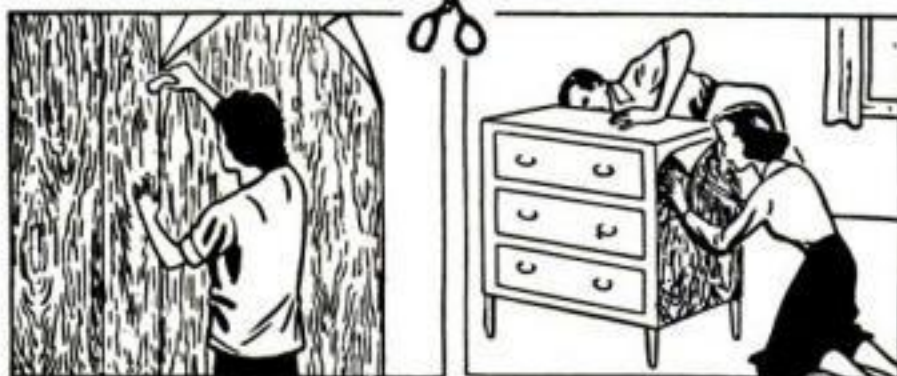
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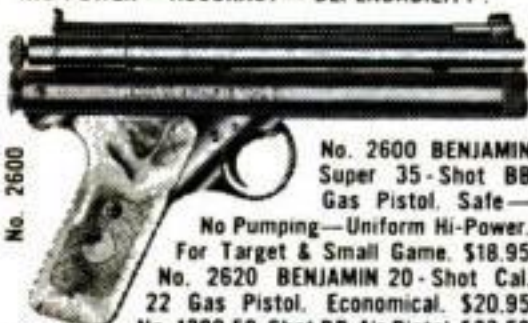


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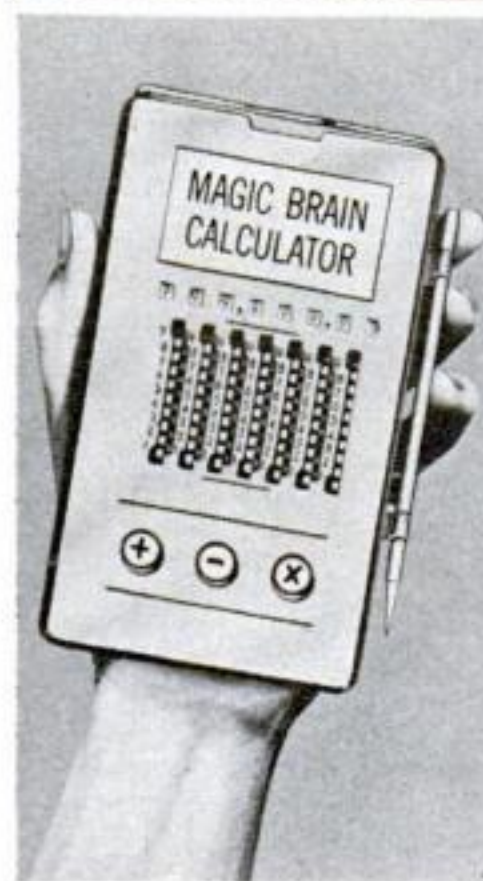
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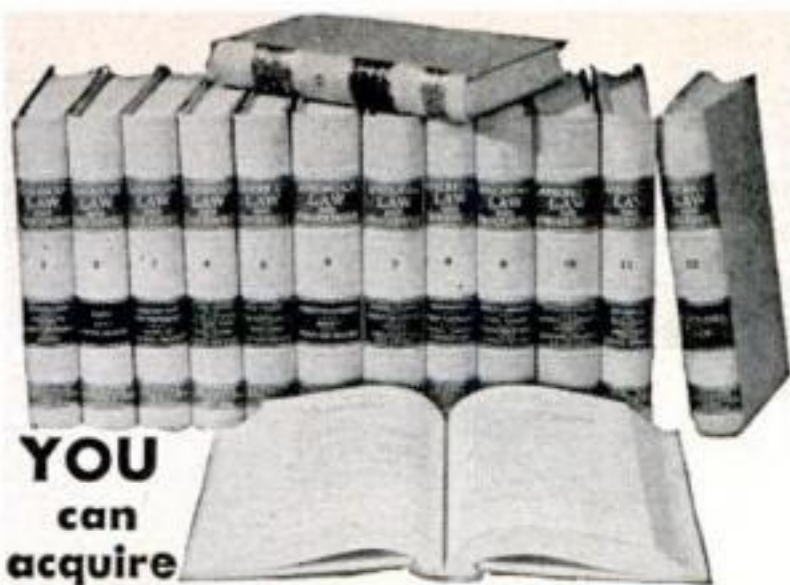
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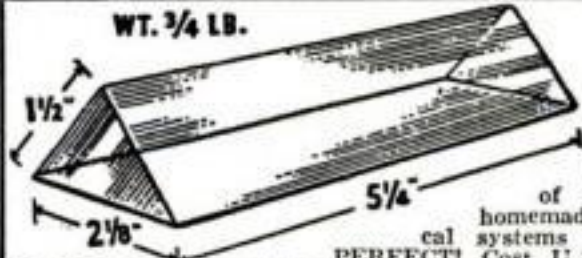


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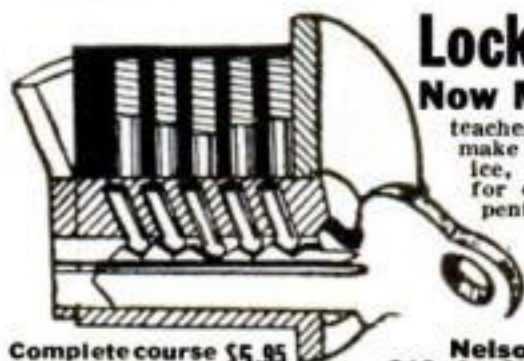
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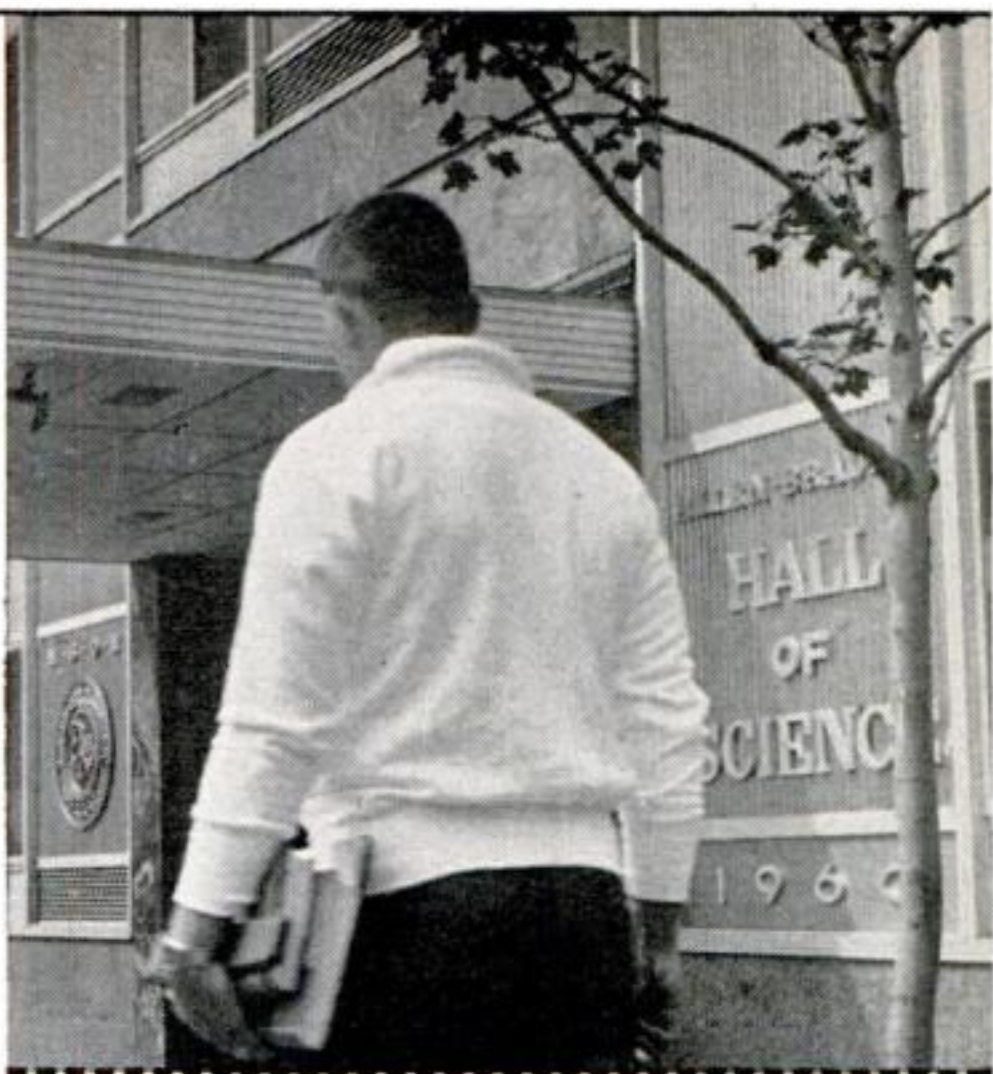
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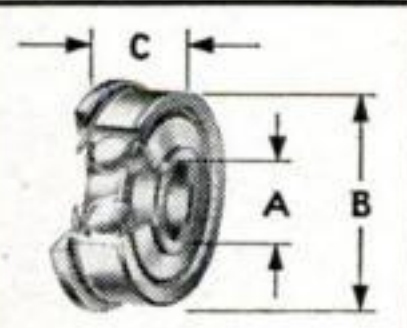
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Gus Looks Into a Trunkful of Trouble

By Martin Bunn

BARRELING along on his way back to the Model Garage that Saturday morning, Stan Hicks, Gus Wilson's right-hand man, yawned contentedly as the wrecker's big engine hummed under his feet. Ahead a car was stopped, and Stan's throttle foot lifted instinctively as he approached.

Four men milled about the car's open trunk. At the sound of the wrecker, they turned almost as one. When Stan was still 50 yards away, they dropped the trunk lid.

It was an old gray sedan, with scabrous paint and battered fenders. All four men were unshaven. A party of hunters, Stan figured, from upstate.

"Hi!" he called. "Need any help?"

Four pairs of eyes studied him coldly.

"Not a thing, son," said one man.

Annoyed by the "son," Stan nevertheless added: "If you're out of gas, I've got a can with me."

A man with a bald head and hard blue eyes leaned on a fender, one hand in his pocket. He shook his head. "Got gas."

"Okay," said Stan. "Okay!"

He let in the clutch. Steady stares followed him as he moved off.

"Friendly guys!" muttered Stan, and turned on the radio the wrecker carried for highway and weather reports.

Music soon revived Stan's good spirits. But 10 minutes later it was interrupted by a breathless announcer.

"... The Bank of Evansville was broken into during the night, police disclosed early today, and robbed of a sizable sum in cash and negotiable securities. The exact loss was not revealed. Prime suspects are four men who fled a diner when a bulletin announcing the robbery came over the radio. Driving an old car with a hopped-up engine, they escaped police in a 90-m.p.h. chase. More news. . . ."

"Holy smoke!" breathed Stan, and bore down on the throttle until he eased the



When they came out of the restaurant, Gus carried a big paper bag. The stranger's right hand was still ominously hidden.



CONTINUED

wrecker slowly into the Model Garage.

"How did it go?" asked Gus.

"Okay," muttered Stan. But as he went out to lock the gas pumps for one-o'clock closing, his mind mulled over the highway incident.

Should he tell the state police about it? What did he have, after all? Four men in a rattletrap car—there'd be plenty like them on the road this weekend. But few so downright unfriendly!

"Something on your mind, Stan?" asked Gus as he came back inside.

"Sort of," said Stan. "But it's like a miss in an engine—you can't be sure it's what you first think."

STAN left on foot, headed for the barber shop. He was waiting for the corner light when a bus stopped across the street. With a start Stan recognized the passenger getting off: the blue-eyed man from the stalled car.

The stranger entered the Model Garage, his right hand in his pocket.

Plagued by doubts, Stan stepped between two buildings and waited. Five minutes later, Gus and the stranger came out together—and entered the small restaurant down the street.

When they came out, Gus carried a big paper bag. The man was empty handed, his right hand still ominously hidden. They walked back to the garage and a minute later Gus drove off in his well-tuned coupe, the stranger beside him.

As they turned the corner, Stan made a dive for his elderly convertible. Retracing his road-call route, he caught up to Gus in 10 minutes—just as the gray jalopy fell in behind the coupe.

But about a mile farther on, the gray car's speed fell off, dropping to 40, 30, and finally 20 miles per hour. Stan fell back. When the two cars came to a full

stop, he hastily swung off where a shoulder of rock hid his car, got out, and looked ahead.

Five men, counting Gus, were huddled around the trunk of the old car. It was too far to see what they were doing. Then the trunk lid slammed, engines started up, and the cars were off. Soon, both turned in at a stone gateway.

"The old Marlow house," mused Stan, driving past. A hundred yards away he parked off the road, and cautiously approached the house. In the yard, hidden from the road, were both cars.

"This," thought Stan, "is where anybody with sense calls the cops."

Instead, he crouched behind a high hedge and peered through. The car's trunk was open again. Four men were bustling about it. Fascinated, Stan tried to ignore a small nagging worry. But suddenly it hit him hard: *four* men, and one was Gus!

"Hold it," a voice behind Stan barked. Stan turned—to see the missing fifth man. "Now stand up

and walk over to those cars."

The trunk was slammed shut as Stan walked over. Four men glared at him, only Gus's eyes crinkling above a grin.

"Did you go to the police, Stan?"

"No, I—gosh, Gus, do you *know* these guys? You helping them?"

"Told you a car was tailing us," put in a tall tow-haired man.

"It's okay," said Gus. "He won't talk."

Dismayed, Stan looked at the grim men and the old car.

"It's not what you think, Stan," Gus said. "I heard that news flash, too. But these fellows are no bank robbers. Meet Tim Hendricks. He went to school with me."

The bald, blue-eyed man extended his

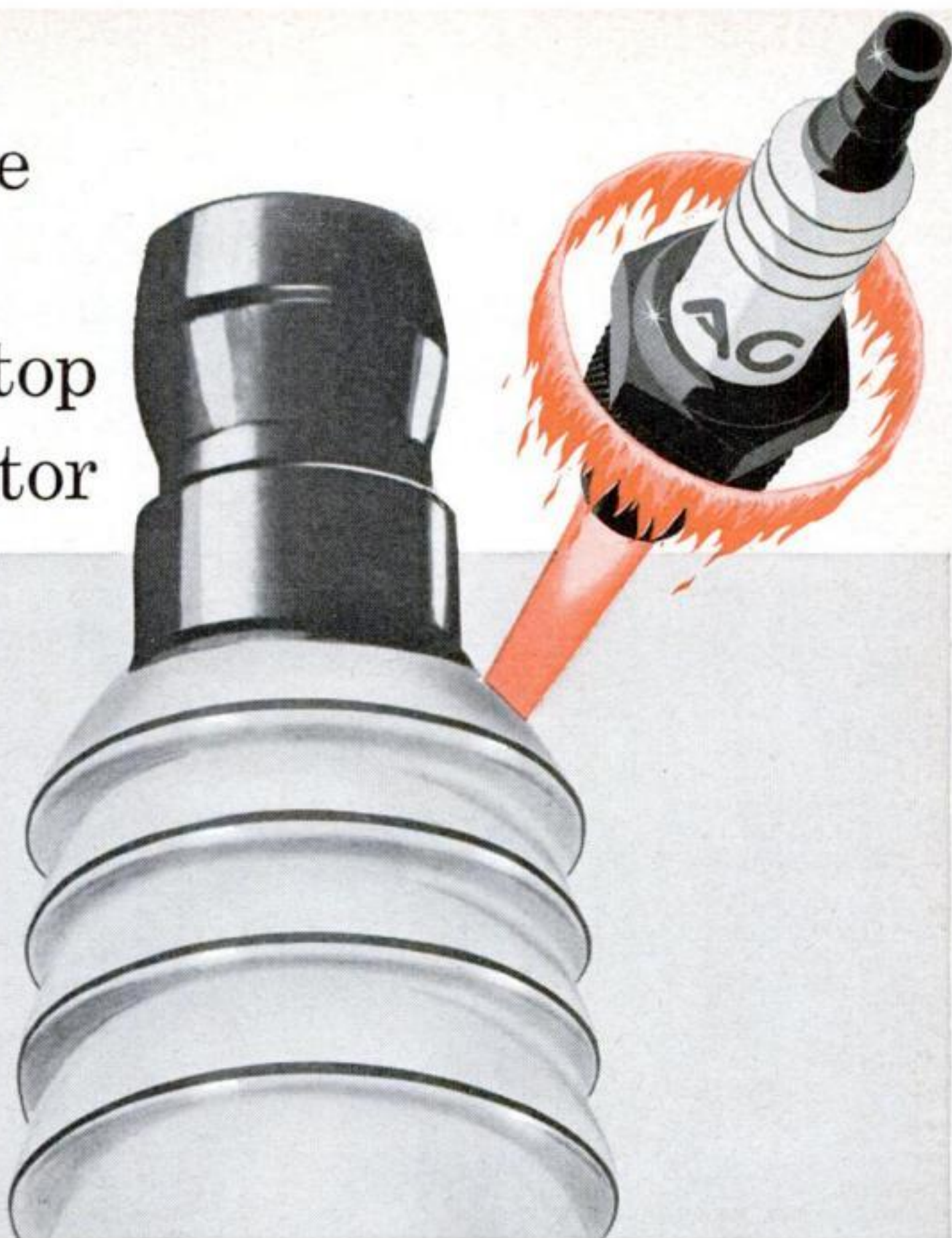
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left hand. "Bunged up my other pushing a wrench this morning," he said, taking a bandaged fist from his pocket.

"Tim's a crackerjack machinist and a good practical engineer. He runs a shop in East Hardwick. Does a lot of experimental work," explained Gus. "Okay to show Stan?" he asked the men.

They nodded. Gus opened the trunk. Inside gleamed the finned, silvery bulk of an air-cooled engine.

"These fellows are test-driving a new aluminum engine they designed and Tim put together, Stan. It's secret—still not covered by patents."

"Makes us edgy," put in the man behind Stan, holding nothing more lethal

"It's set rich," explained Tow-Head around a hamburger. "Maybe that's why we burn so much gas on starts."

Gus looked up sharply. "What sort of weather does it conk out in?"

"Just like now. Cold, wet days. Not in that zero spell last week."

"That was dry cold," said Gus. He loosened the air-scoop clamp and started the engine. It galloped into life, ran steadily, and gradually grew rough. Gus fingered the automatic choke.

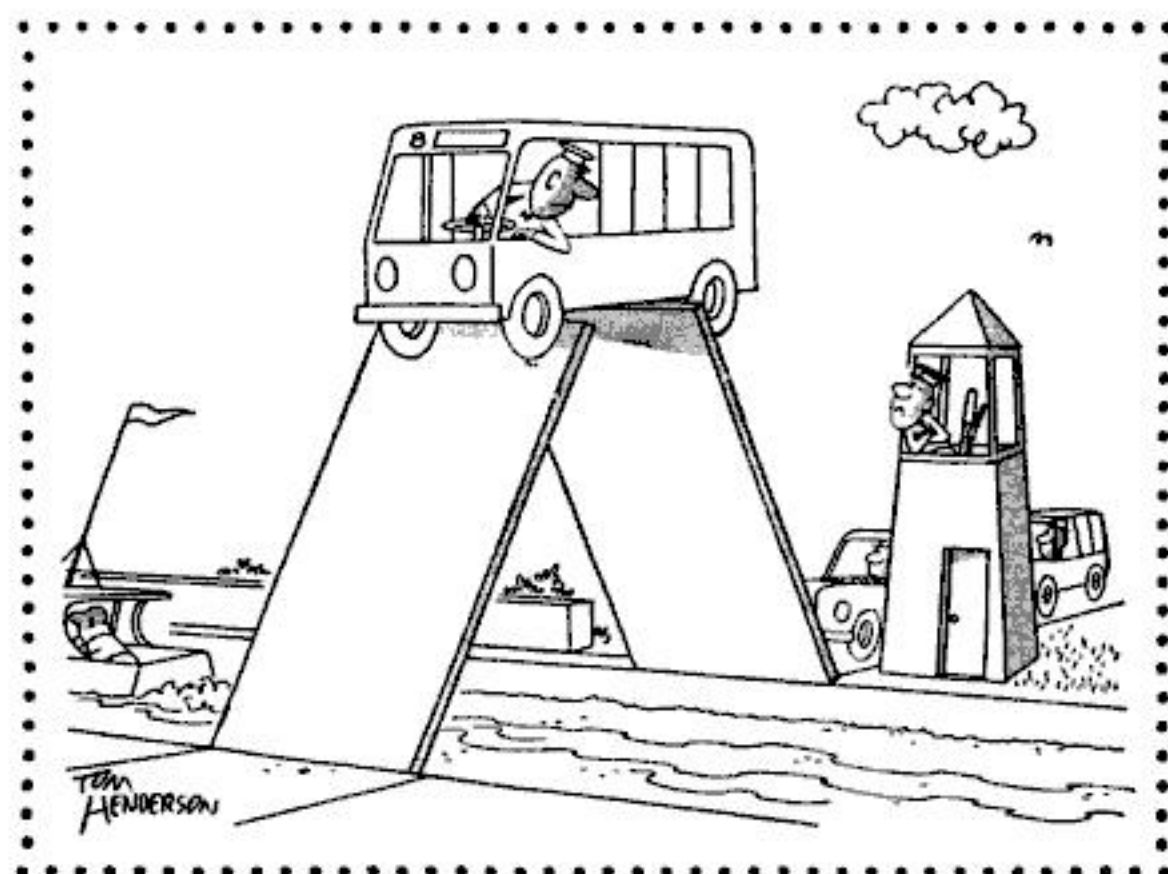
"Nothing stuck there," he said, and motioned to Stan to cut the engine. At once he lifted the scoop to peer into the carburetor throat. Stan saw a glint of white deep in the venturi.

"Your new engine," announced Gus gravely, "has a very old complaint—icing."

As Stan looked puzzled, his boss explained. "Air rushing through there expands on the other side. Expansion cools it. If it's cold and wet to begin with, the water freezes out and chokes the venturi."

"Carburetor icing!" cried one of the men. "Gas-gulping starts, symptoms of overchoking, a mill that quits but runs again after block heat melts the ice."

The tow-headed man nodded. "We muffed all the



than a meerschauum pipe. "Anyway, maybe we haven't anything to be secret about. Engine's got a weird bug that has us stymied."

"It loses power," put in Tim. "Quits, then cures itself after standing a bit. We didn't dare risk stalling in town. But seeing the name on your wrecker reminded me how Gus could lick hidden bugs, so I brought him out."

"Along with eats," added Gus. "They worked half the night tearing down the engine in a barn. Pitch in!" he ended, lifting a stuffed paper bag onto the fender of the car.

WHILE four tired men wolfed hamburgers and coffee, Gus and Stan studied the strange V-six engine.

"Offset carburetor," muttered Gus. "Could starve the end cylinders."

clues! Got so wrapped up in new problems we forgot to check out old ones."

"It's easy to fix, now we know," said Tim. "A warm-air duct should help. Gus, you did it again."

"We're mighty grateful," added the fourth man. "We'd begun to think this new engine was a lemon and we'd have to start all over."

"After a year's sweat and tears, too," groaned Tow-Head.

"Luckily," said Gus, "things aren't always what we think. And that reminds me, Stan, we heard a spot bulletin while driving out."

"They caught the bank robbers in the hopped-up car?"

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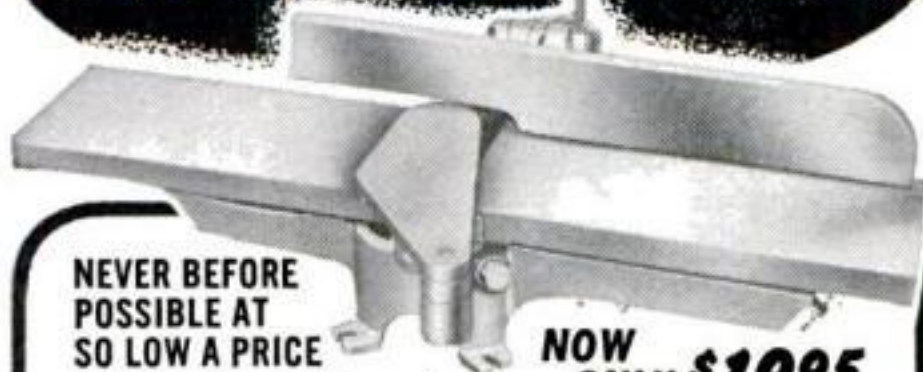
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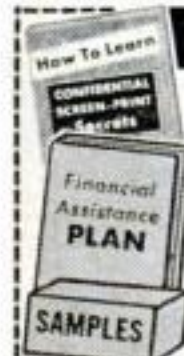
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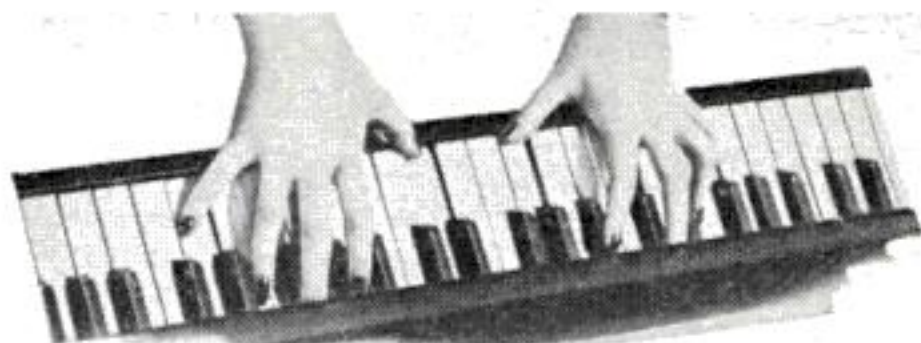
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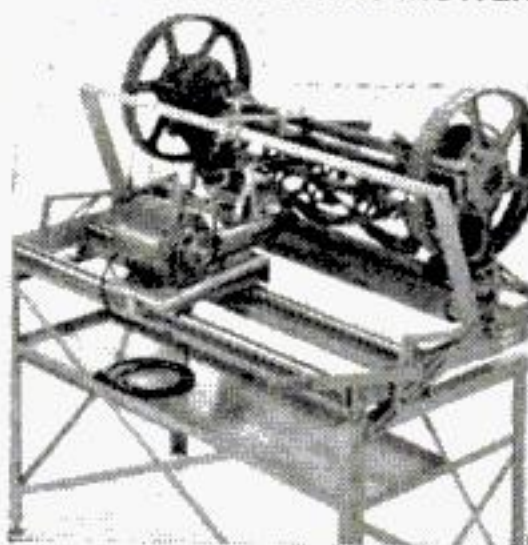
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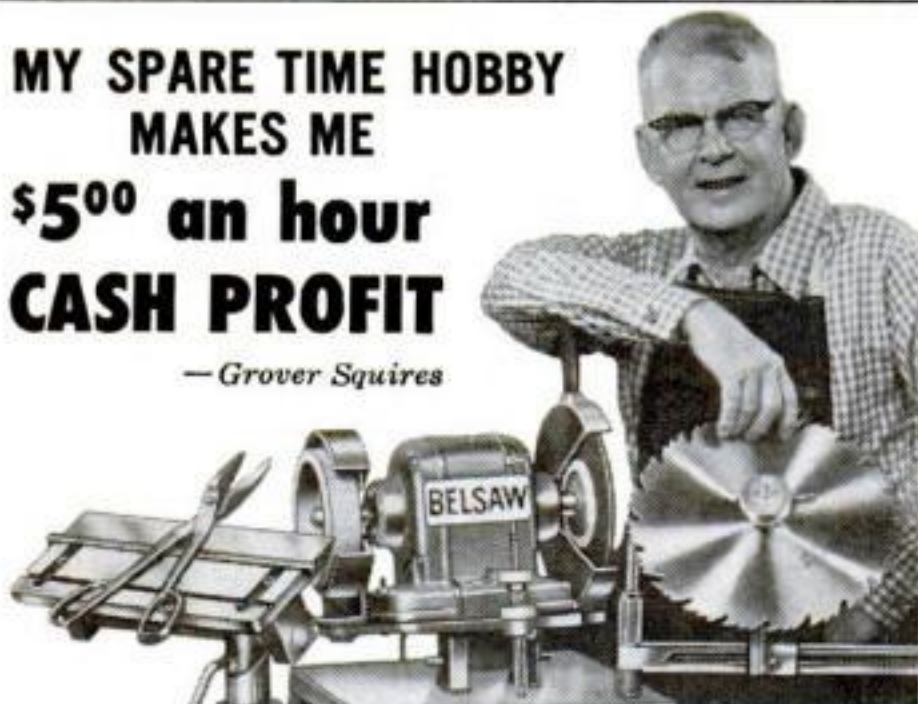
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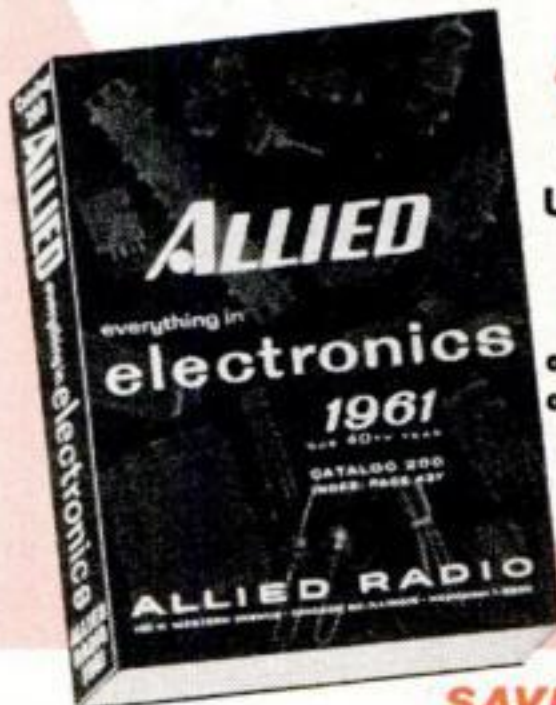
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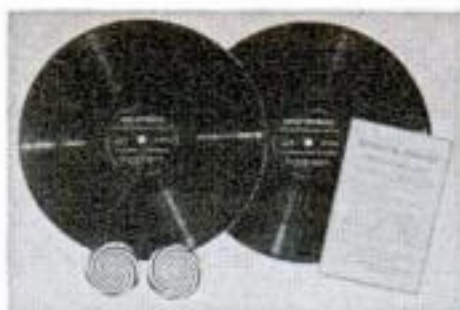
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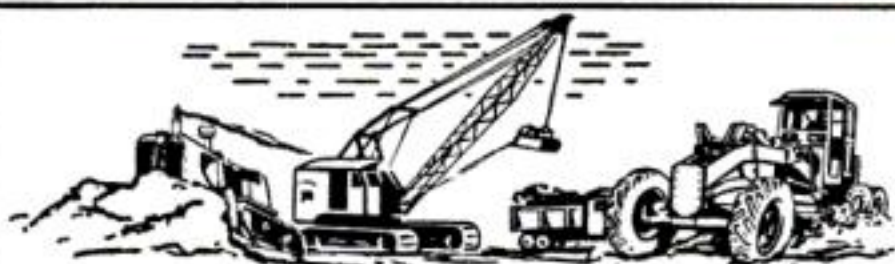
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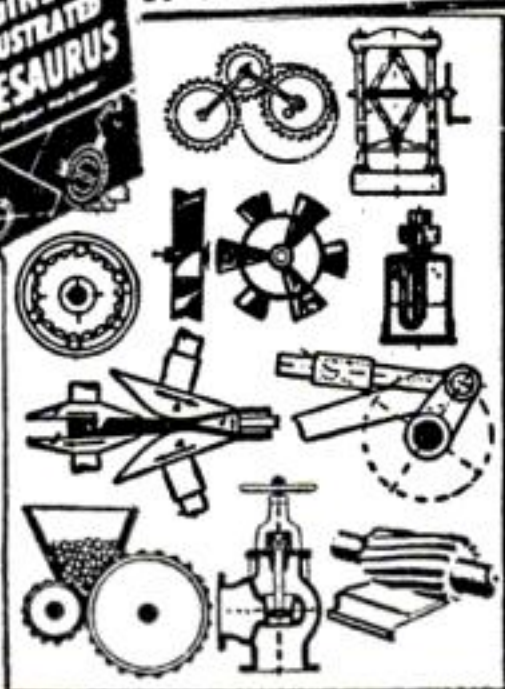
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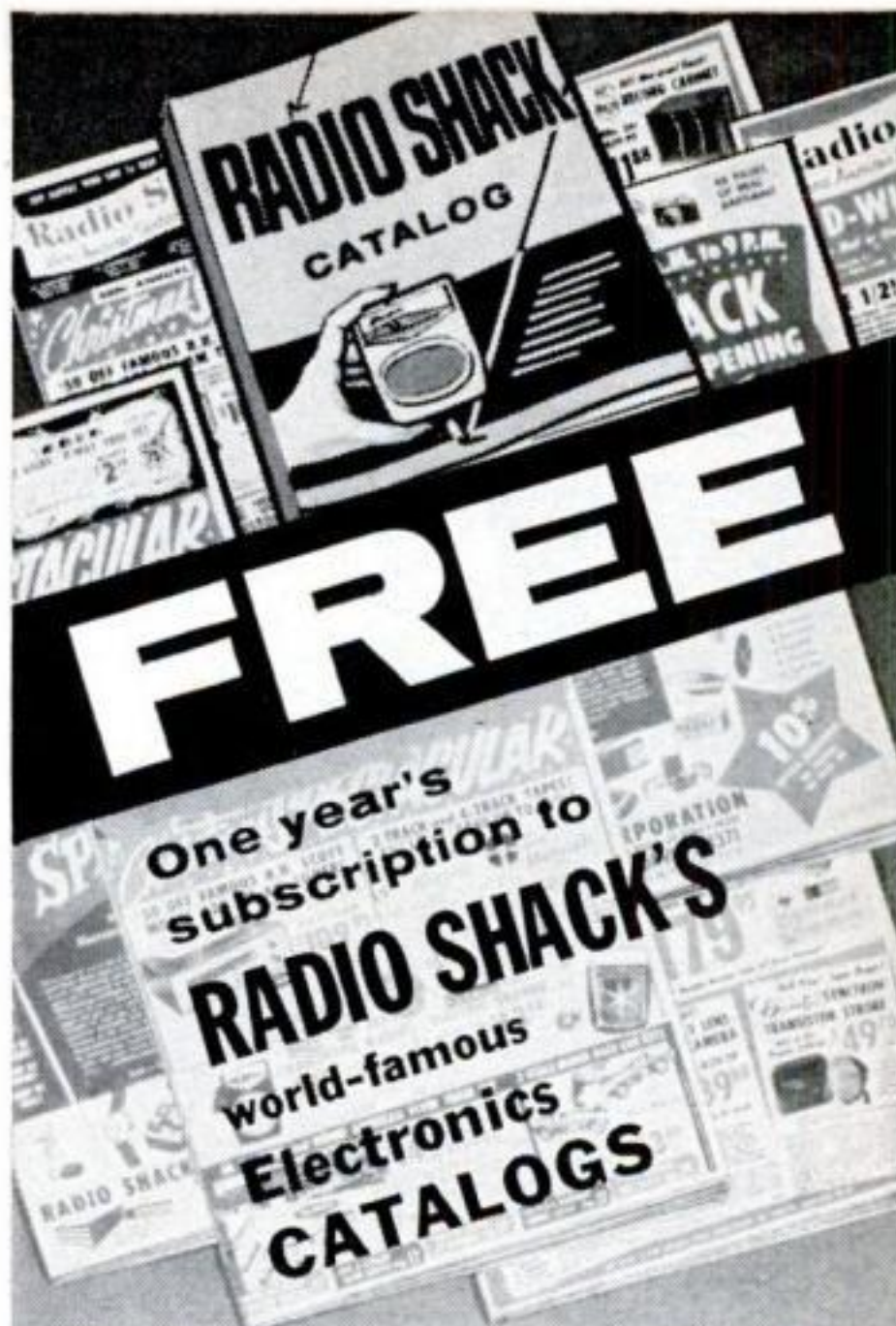
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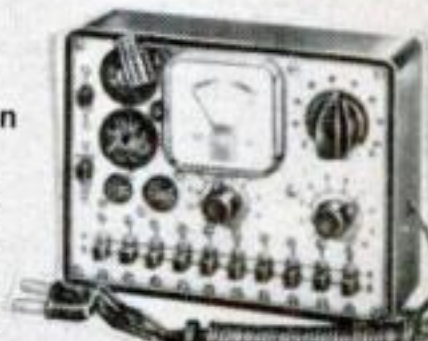
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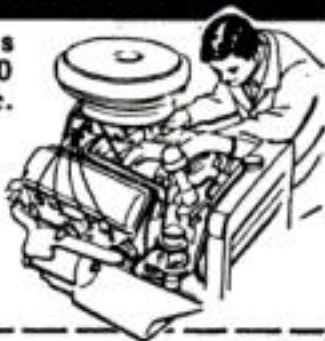
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Ford's Cardinal to Use V-4

THE various engines reported in previous columns as under development for Ford's compact-compact have been sorted out. Final choice is the narrow-angle V-4 mentioned here in August. It has a displacement of 108 cubic inches and puts out about 65 horses. It's water-cooled and has a cast-iron block.

Initially, this engine was made without a fan and the drive shaft extended forward, driving the front wheels. It persisted in overheating, however, and front-wheel-drive proved to be either too expensive or too troublesome.

To bypass these difficulties, Ford engineers went back to a more conventional design. They switched the engine end for end and added a normal cooling fan run off the drive shaft. (Earlier prototype engines had both electrically driven fans and weird arrangements in which the camshaft was extended with a fan bolted to its end.) The V-4, still hiding under a Saab hood for test purposes, will

drive the rear wheels on the 96-inch-wheelbase Cardinal when it has been hatched.

Ford's offer to buy complete control of Ford of England indicates that the Cardinal is to be a real international project.

Basic engineering of the automobile is being done right in Dearborn, but ultimate production will be scattered across the U. S., England, and the continent—the deciding factor as to which components will be produced where will be cost. Sales will be on a similar international basis; the car will be sold in this country, but all of Ford's eggs won't be in the domestic basket.

When will the fledgling leave the nest? Probably not before the 1962 new-car season, and it looks now as if the introduction might be even later. Too many loose ends are still hanging for the Cardinal to be nudged out in anything less than six months.

.....

Cross ventilation. The stationary rear windows in the one-piece, lift-up tailgates of early Olds F-85 and Buick Special station wagons drew so much criticism that they were scrapped. Wag-

ons coming off the line for the past month or two all have roll-down windows as standard equipment. It costs more to build them this way, so \$27 has been tacked on to base prices.

.....

Check those crankcase ventilators. Anti-smog crankcase ventilators being used on many 1961 cars need periodic maintenance, warn engineers from AC Spark Plug Division of GM. The valves in the positive ventilation systems, which route unburned hydrocarbons from the crankcase back into the engine to be burned during combustion, should be inspected at every oil-filter change—

or every 5,000 miles. They should be cleaned or changed every 10,000 miles or they will clog and fail to provide adequate air flow through the system.

AC has developed a test device to check the crankcase ventilators. It has an adapter plug that fits into the oil-filler or breather-cap opening. Condition of the system is revealed by color coding visible through windows in the tester.

.....

Bigger wheels for small Buick. You can't leave customers hanging, so Buick recently announced its compact Special with 15-inch wheels instead of

the standard 13-inches. The optional bigger wheels give customers in rural areas a bit over half an inch more ground clearance for rutted roads.

WHY ISN'T THIS SPARK PLUG CHROME PLATED



?

Almost everyone agrees, Autolite doesn't make the prettiest spark plugs in town. The new shiny kind are much more attractive. Obviously, there is a reason why these plugs are blue. The color itself doesn't make any difference. But it does tell you a lot about the way the spark plug is made. Example: The way the shell is sealed to the insulator. This seal guards against loss of compression, sluggish performance, poor fuel economy. In building its blue plugs, Autolite seals the shell to the insulator under tremendous heat and

pressure. No plated shell could stand this treatment; it would crack, peel, discolor. Plated spark plugs are usually caulked with powder and the shell crimped to the insulator. Is this difference in sealing methods really this important? It is if you are an economy nut, or a performance nut, or just a guy who doesn't take chances on anything he buys for his car. Next time you need a new set of plugs,



AUTOLITE

remember two things. For top performance and economy, the color is blue, the name is Autolite. Toledo 1, Ohio.

Fish Grab My Hook Without Caution ...Attack so ravenously...

I CATCH FISH LIKE CRAZY!

My Secret is My French Patented Lure
That's **GUARANTEED TO CATCH FISH**
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BY EMILE PLANES
(AS TOLD TO PAUL STAG)

Here is how I catch more fish than I ever caught in my life before. . . . More fish than I ever dreamed of — and BIGGER fish than I ever suspected possible. Here is how you can catch bass, pike, perch, bream, trout, salmon, crapple, pickerel, walleyes and many, many other kinds of fresh water game and pan fish plus many salt water fish . . . the same way I do.

Since I invented my fishing lure, I catch so many fish, such BIG fish, and catch them so FAST, people gather to watch me. I've been followed FOUR TIMES in ONE day by a fish warden to find out if my methods are legal. But my entire secret is my fishing lure that's **GUARANTEED TO CATCH FISH** — or it costs you nothing. Yes, **GUARANTEED** to catch fish even when other lures or even live bait fails or no cost.

My lure works in lakes, ponds, streams, salt water, saves you time, work, money and disappointment, is ideal for amateurs, experts, trollers, casters, shore fishermen. My lure catches fish differently from anything you've ever seen before in fresh and salt water. Even veteran U. S. fishing guides have been surprised at its astonishing catches. And the French Government itself has certified my lure by actual patent as **UNIQUE!**

An Underwater Discovery

I am a Frenchman, a science teacher, a skin diver and I have fished all my life. For years I have studied fish underwater — **WHILE FISHERMEN ABOVE WATER** were trying to catch them. What I discovered changed every idea I ever had about fishing and fishing lures.

Lures Can Frighten Fish Away

I watched **UNDERWATER** exactly how fish reacted to every lure, live bait, every fishing maneuver and trick used to catch them. I watched fish approach even the best performing lures, seem **ABOUT TO STRIKE** — then suddenly **TURN AWAY**. Something about even the best performing lures was obviously often **KEEPING THEM FROM CATCHING** fish. As for the average lure, mostly they seemed actually to **BORE** the fish — as though they looked to the fish as they looked to me **UNDERWATER** — shiny, painted bits of metal, plastic and wood. I saw live bait after it was cast turn white and die before my eyes — and saw fish often approach, prepare to strike — **THEN TURN AWAY**.



HOW VIVIF WORKS!

Fish have never seen anything like this lure before. It attracts fish by its vibrating tail. It is the world's most life-like lure in the water. Fish can't resist it . . . and when they grab the lure it "feels" lifelike — doesn't warn them to spit it out before you can sink the hook in! Read this article and learn the amazing story of this imported lure.

Minnows Irresistible

Then I saw the same fish approach actual live swimming minnows and without caution or suspicion **STRIKE RAVENOUSLY**. I saw the same fish that rejected the lures again and again attack without caution **LIVE SWIMMING MINNOWS**. In fact, these little minnows seemed to **DRAW** many fish from a distance—even before being seen.

Why Lures Often Fail

My talks with fish scientists and my own studies convinced me it was the swimming motion of minnows, particularly the swishing tail that attracted many fish. I concluded that no lure I had ever used had **SUFFICIENTLY** duplicated the living minnow and its motion.

How, I asked myself, could a fish lure be created that would attract fish just as the actual living swimming minnows did — and that once attracted would get the same ravenous **STRIKE** as live minnows — **WITHOUT** the hesitation, suspicion and **FEAR** aroused by the lures I saw used?

My Man-Made "Minnow"

After 19 years of study and testing, I have finally created such a man-made "minnow," so like a living, swimming minnow in shape, form, texture and motion that fish ravenously **STRIKE** — without caution — and I catch more fish, bigger fish — and faster than ever before in my life.

Because my man-made "fish" looks, darts, wiggles, even "feels" like a minnow . . . bass, pickerel, pike, perch, trout and many other kinds of fresh and salt water fish attack voraciously — without suspicion or fear — even when they're not biting for another fisherman on the lake.

Astonishing Catches Reported

I call my lure **VIVIF**. Once I perfected **VIVIF** I started selling them to other fishermen. Soon news of astonishing catches came in — first France — then from other countries.

Yes, from all over comes reports of amazing catches — of fish biting where other lures failed — of the sureness, the simplicity, the effectiveness of this **VIVIF** lure. And what does this mean to you?

Simply this. Now **YOU** can get more out of fishing than ever before. Now **YOU** can catch more fish, bigger fish than ever in your life. It is **GUARANTEED** — or you pay not one penny. It means now no longer need you come back with an empty creel from a long day's fishing. It means no longer need you spend hours of work digging worms and catching minnows or other bait. It means you can save the endless expense of continually buying expensive spinners, flies, plugs, bait and lures. It means you can often catch the fish that are not biting on worms, bugs, plugs, spoons, canned bait, flies, cut bait or spinners or no cost. It means you can troll, cast, or shore fish with my lure with equal success. It means you can go out after and come back with large mouth bass, small mouth bass, pike, pickerel perch, bream, trout, walleyes, salmon, red tuna, striped bass, blue fish, weak fish and do it time and again — or your money will be refunded at any time. **VIVIF** is catching fish in 25 countries for delighted fishermen. 1,050,000 **VIVIF**'s have been grabbed up. Already reports from U. S. fishermen say **VIVIF** is the greatest lure they have ever used. I predict **VIVIF** will soon be the world's fastest selling fish lure. But test the magic power of **VIVIF** yourself without risking a penny.

VIVIF IS IMPORTED SUPPLIES are LIMITED

To get your **VIVIF** now, mail Amazing Trial Coupon. U. S. supplies are still limited. Order now to be sure you'll have your **VIVIF** in time for your next fishing trip. Only if you act at once can we guarantee to fill your order immediately. Don't delay.



THIS IS EMILE PLANES, Science Instructor, Skin Diver, ardent fisherman from Beauce, France, who went underwater to find out why fish reject certain lures and chase others . . . and who, as a result of years of observation, research, and development, finally created a true-to-life man-made minnow that practically no fish can resist . . . that holds an all-time Char Trout record in Britain, and has made amazing catches in this country and all over the world. Read on this page how you can try this amazing minnow that's **GUARANTEED TO CATCH FISH OR IT COSTS YOU NOTHING!**

AMAZING TRIAL OFFER

It took me 19 years of hard work developing, improving, and perfecting **VIVIF** to achieve my final result. But you can test the magic power of **VIVIF** yourself without risking a penny. **VIVIF** takes the luck out of fishing, lets you have more fun out of fishing — because you catch more fish.

All you do is mail the no-risk trial coupon below. When you receive your **VIVIF**, use it anywhere you like . . . to prove its fantastic fish catching powers. Use it to catch bass, trout, perch, pickerel, pike, walleyes . . . any sport or pan fish you like to catch.

Put **VIVIF** to every test. If you don't agree it is the finest lure you've ever used . . . if it doesn't catch more fish and bigger fish, you have used it entirely free. It won't cost you a penny. Read amazing trial offer below.

Over 1,055,000 Amazing **VIVIF**'s Already Sold Throughout The World. Be The First In Your Area To Own One.

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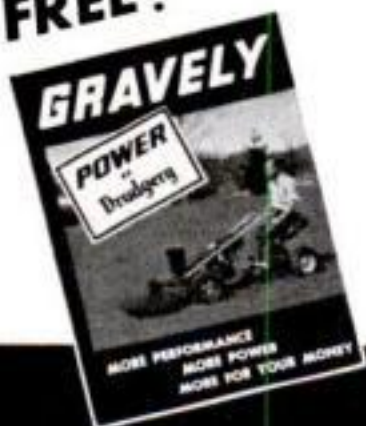


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In a Land Rover, Who Needs a Road?

By Alex Markovich

THE scratched and mud-spattered Land Rover inched its way up the 65-degree slope, the steel cable on its winch groaning. For miles in all directions stretched the almost impassable Darien jungle swamp of Panama and Colombia.



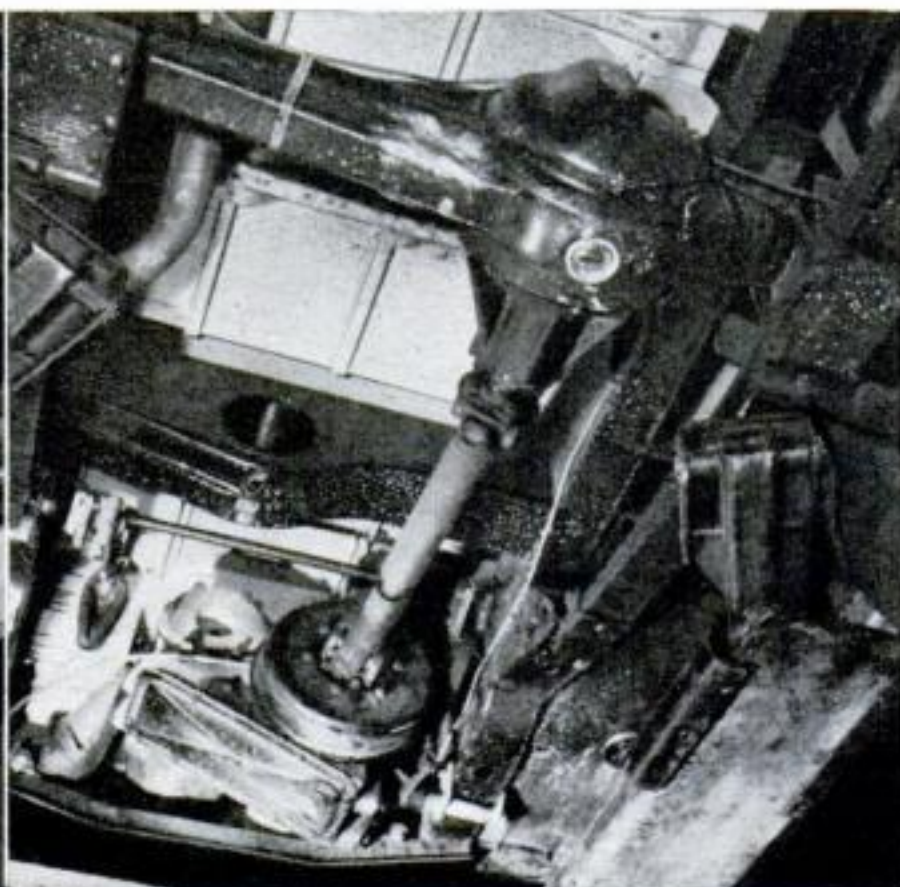
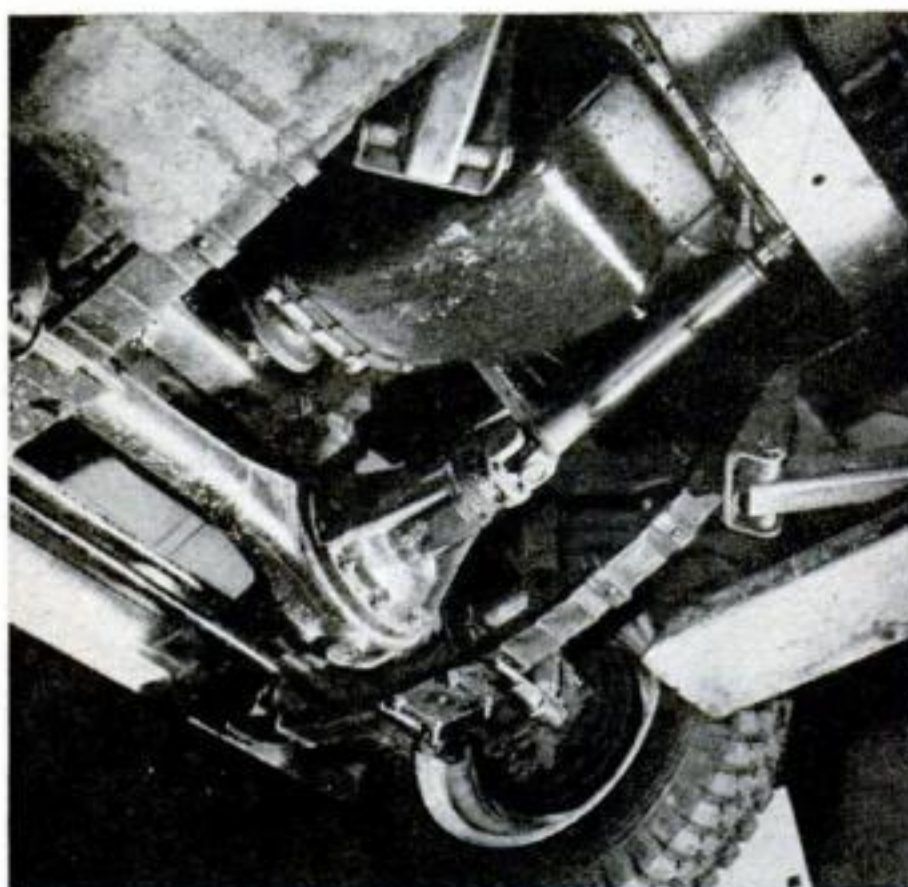
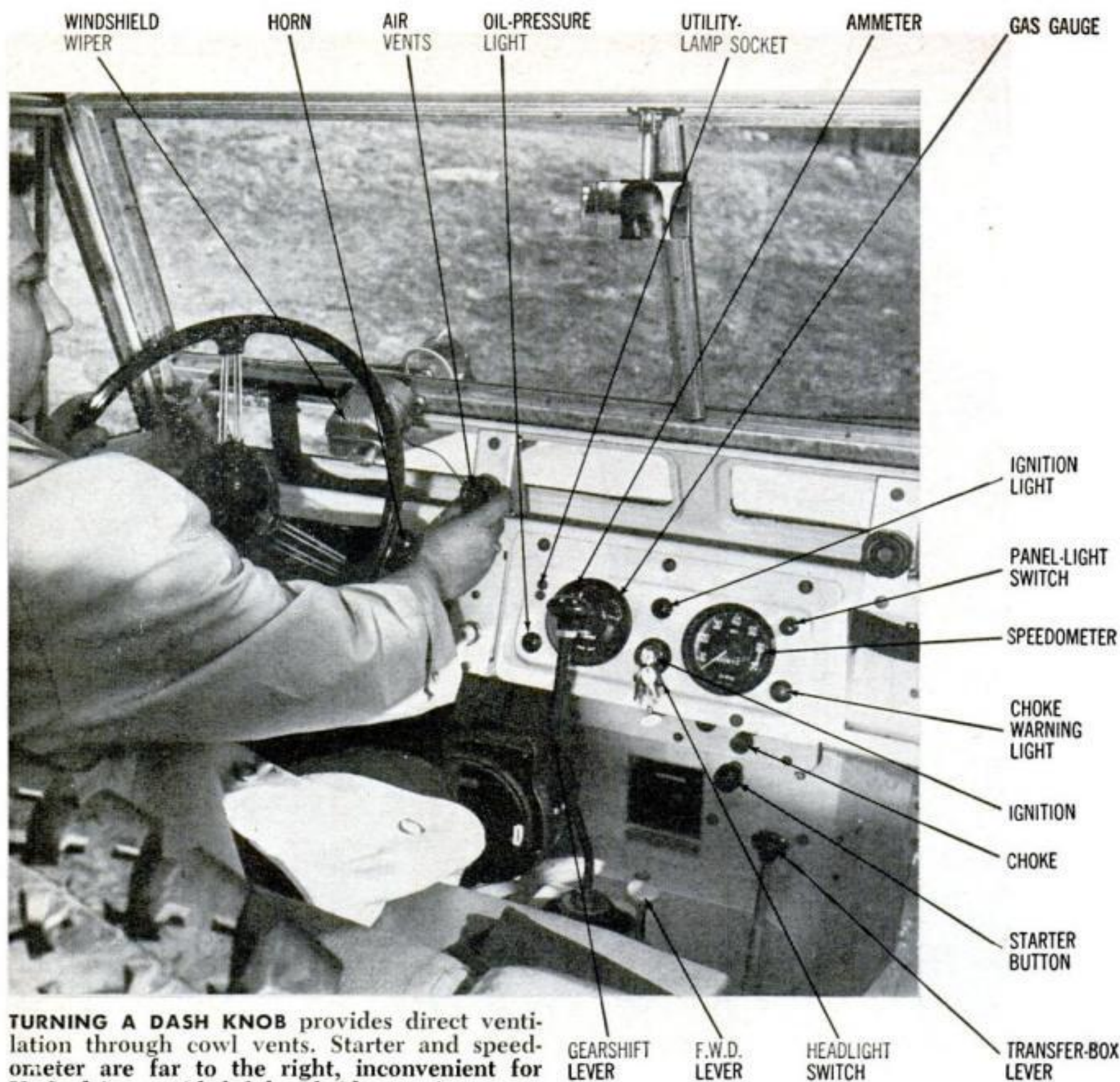
ROADS JAMMED with traffic? Just cut around through the woods. Plunk 'er into low-ratio four-wheel drive and the Land Rover climbs like a scared goat. The 40-degree slope below was child's play. Aluminum body is noncorrosive; enamel paint covering it is strictly for looks.



The great white hunter's best friend, this spunky four-wheel-drive vehicle rivals the Jeep

CONTINUED

67



MASSIVE SUSPENSION boasts semi-elliptic leaf springs and telescopic hydraulic shocks at front

(left photo) and rear. Road clearance under the differentials is eight inches.

Suddenly, near the crest of the hill, the car somersaulted backward and crashed upright against a tree 70 feet below. A pin had sheared in the winch. Thanks to seat belts and the sturdiness of the car's body, the driver was unhurt. The engine restarted on the first try, and within minutes the expedition was off again to complete the first crossing of Central America by car.

Nearly a third-way around the world in Holland, a freight-yard foreman was puzzled when a newly bought Land Rover burned out its heavy-duty clutch in a few weeks. The car had been bought for towing two or three unladen 10-ton railroad cars at a time. He investigated, and found that one eager-beaver driver had been towing four and five at a time. In fact, the driver boasted, he'd once hitched up and moved four empty cars and one fully loaded one—about 150 tons.

Nearly every Land Rover owner has some similar tale to tell. Land Rovers have been sat on by confused elephants and charged by enraged rhinos. They've plowed through quicksand, floorboard-deep water, Sahara sands, and arctic snow. Hardly an area remains in the world that hasn't been crossed by the plucky four-wheel-drive vehicles. Consequently, when I went to pick up our Land Rover my curiosity was tinged with awe. Would the car really live up to its reputation?

A Jeep with a British accent. I took delivery of the stubby little station wagon in Long Island City, N. Y. It was fully eight inches shorter than a VW, though much higher. All the aluminum and galvanized-steel body panels were squared off to cut tooling costs and eliminate needless overhang.

The interior was strictly practical; no niceties such as door upholstery, head liner, or floor mats. Leg room was scant, even for my five-foot-eight frame.

The four-cylinder, 77-hp. engine started instantly. I pushed the four-speed floor stick into first and rolled away. I soon found that second gear, like first, isn't synchronized and requires double-clutching. Additional ratios are provided by a transfer box; in effect, eight forward and two reverse speeds are available.

Riding the parkway leading upstate was a pleasant surprise. Though built for the roughest terrain, the Land Rover was



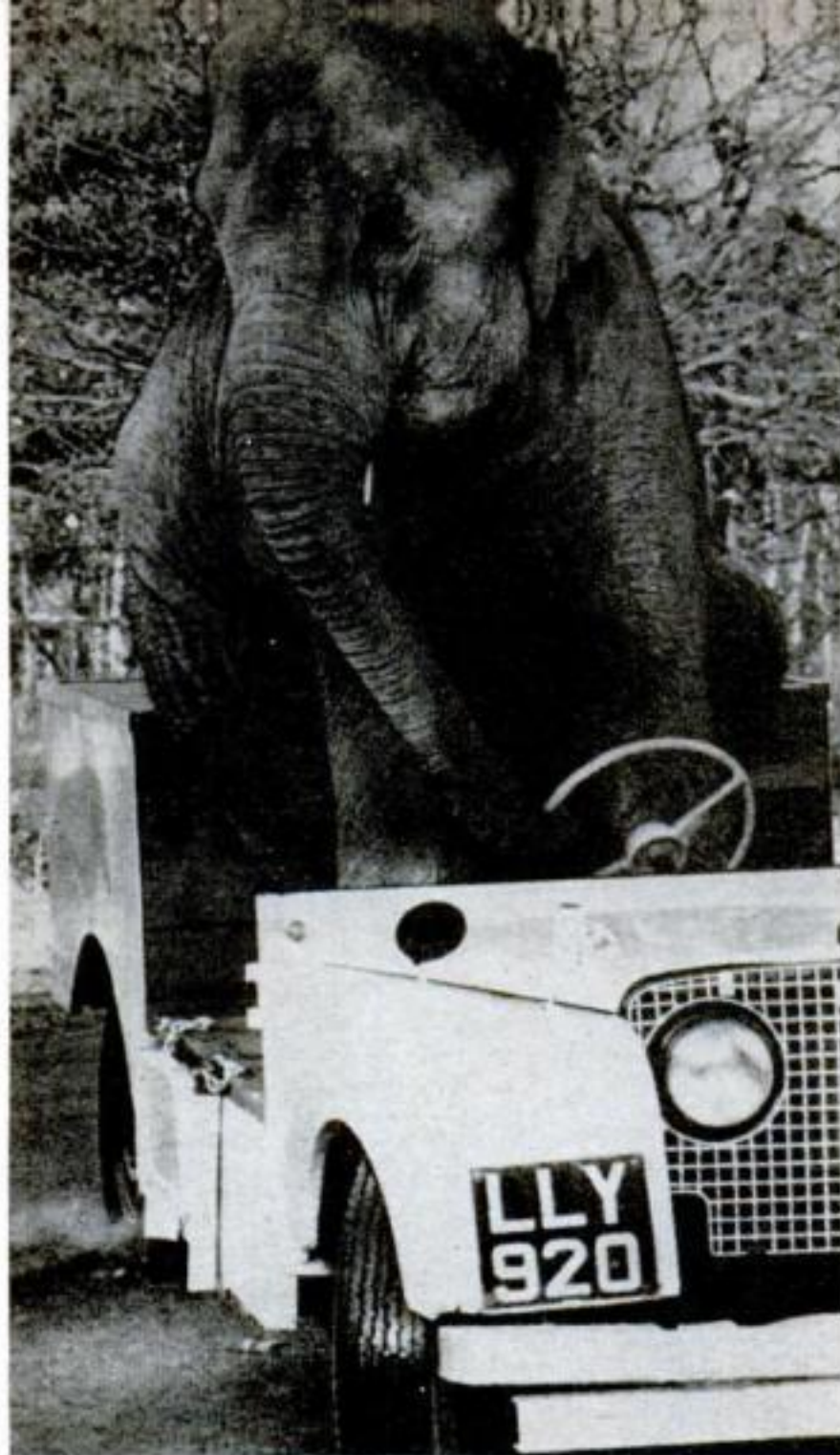
SPRUNG SEAT CUSHIONS LIFT OFF for access to roomy tool compartments. The vehicle is equipped with jack and full set of wrenches.



COMPACT ENGINE COMPARTMENT houses a 139.5-cu.-in. in-line four. A 125.2-cu.-in. diesel developing 51.2 hp. is available at extra cost.



ROOMY REAR COMPARTMENT seats four knee-to-knee. The spare wheel can be mounted on the hood to increase luggage space in the rear.



EVEN ELEPHANTS DRIVE 'EM. This car was specially built by the Rover Co. for an English circus. The animal steers with his trunk, but his front leg provides an occasional assist.



LITTLE DAMAGE is shown by the trans-Darien Land Rover after its backward somersault. The expedition took over seven months to complete a journey from Canada to Colombia.



ELSA, KENYA LIONESS made famous by a recent book, sits on her pet perch, a Rover's canvas roof. Raised from birth by Joy Adamson, she returned periodically when set free.

docile on the smooth pavement. Steering was quick and easy. The heavy chassis and light body resulted in a low center of gravity, so the vehicle cornered well. A major annoyance, however, was the noisy drive train—at 40 the whine made normal conversation almost impossible.

There's a touch of larceny in all of us. Approaching a parkway toll station, I had a fleeting thought of cutting off cross-country. I fought off the impulse.

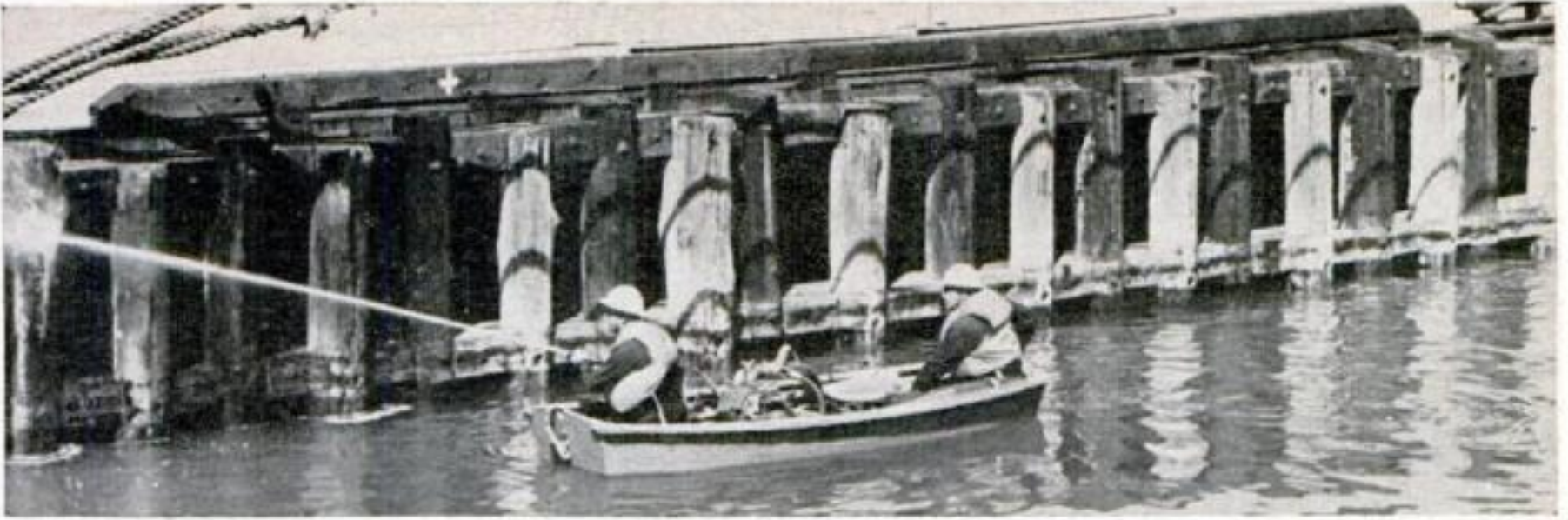
Off-the-road test. Farther upstate I left the road to give the Land Rover a real workout. I pulled the transfer-box lever back into low, automatically putting the car into four-wheel drive, and charged up a 45-degree slope without benefit of a winch. I drove down the other side of the hill with the body leaning nearly 30 degrees.

At the foot of the hill was a shallow stream. I drove into it, followed the rocky bottom a few hundred feet, and

emerged on the other side. By this time the little car had given me a sense of exuberant power. I felt unstoppable. I barreled into a clump of trees, gaily weaving in and out among the saplings. After a few hours I grudgingly got back onto the parkway and headed home to get a woman's opinion.

My wife approached the car with unconcealed misgiving. She thought that it looked like a shrunken Brink's truck. One problem immediately became evident: The lack of a doorstep on the smaller-wheelbase model makes entry difficult for women in skirts. I had to give my wife's bottom a boost to get her in with some semblance of modesty. She probably didn't like the stiff suspension either, but the drive-train noise drowned out absolutely all complaint.

Women just don't seem to understand what a *terribly* practical vehicle the Land Rover is.



Midget fireboat gets into close quarters for battling blazes under pier structures like this.

Baby fireboat propelled by its own pump

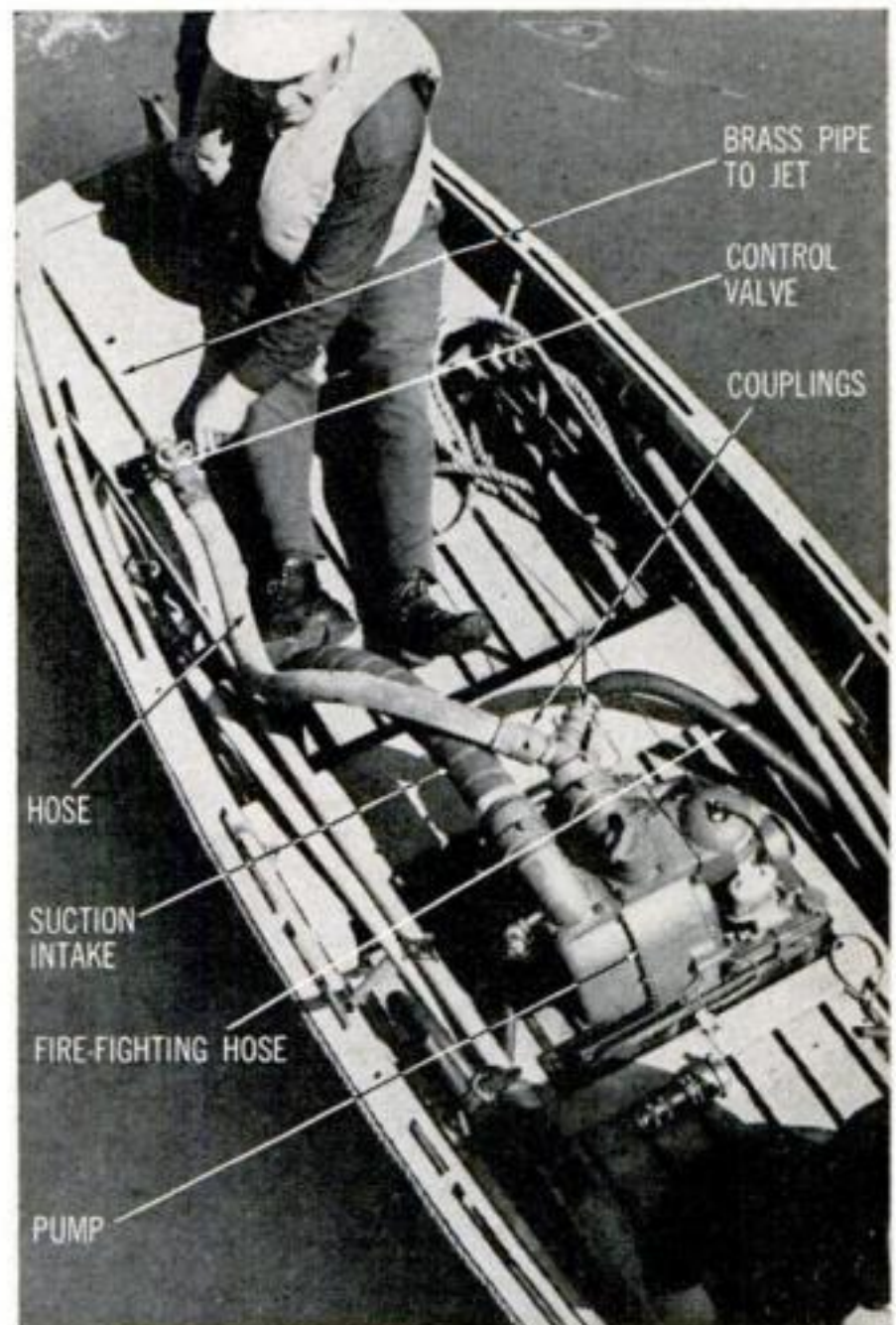
"Fireboat No. 1½," a two-man skiff ingeniously propelled by water jet, fights San Francisco pier fires from underneath.

It used to be rowed to blazes of this sort, but the oars were often a plaguey nuisance in close quarters. So one of the firemen devised a way to let the boat's 300-gallon-per-minute pump provide propulsion as well as douse flames.

He divided the discharge. Part of it can be shot out of a 7/8-inch nozzle at the base of the tiller, thus pushing and steering at the same time. When the pump's full capacity is devoted to this purpose, No. 1½ can make seven or eight knots. Once at the fire, all the flow can be diverted to fighting it, or some of the water used to maneuver the boat.



JET NOZZLE at stern can be swung by tiller to port or starboard to control boat's direction.



JET PROPULSION comes from pump that also provides water for fighting harbor fires.

Compact airplane

A small two-passenger sports and training plane is being put out by Piper Aircraft. Its 108-hp. Lycoming O-235 engine provides a 120-m.p.h. top speed and, with standard 18-gallon fuel tank, 345-mile range. An extra 18-gallon tank is optional. The Colt's base price is \$4,995, a third less than most two-seaters.



Army Bridge Travels Cross-Country



COMBAT-LOADED M-48 TANKS cross a Gillois bridge during maneuvers in Germany. The river

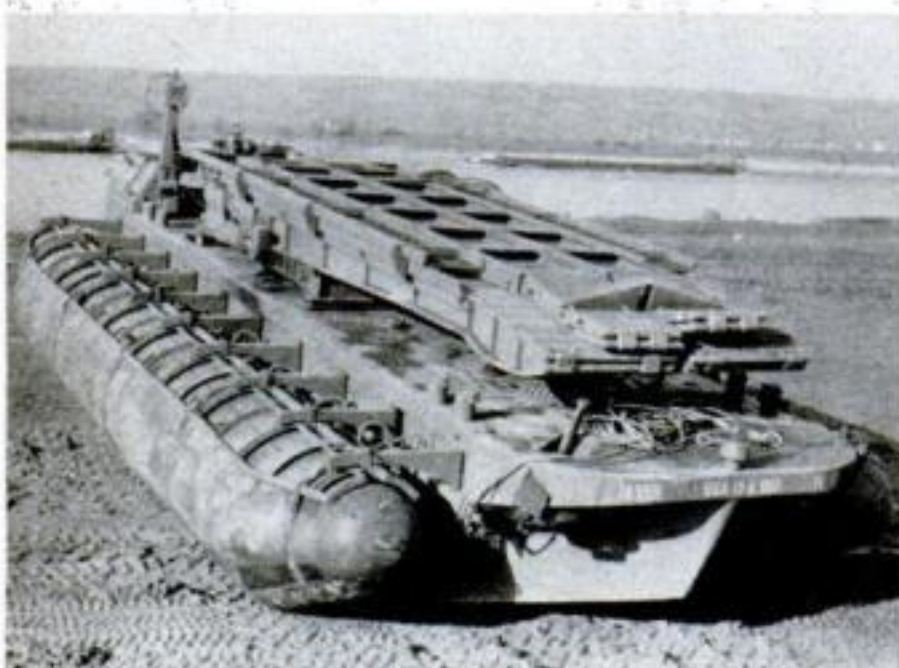
span consists of a 26-foot ramp at each end and bridge sections of the same size in between.



BRIDGE UNIT is shown here on the road. Four bulkheads divide the 36-foot steel-plate hull into a crew compartment, an engine room, two air-filled wells to receive the retractable wheels, and the bow. No economy-run winner, the bridge-toting vehicle gets 2.7 miles per gallon.



AIR COMPRESSOR fills the lowered pneumatic floats with 530 cubic feet of air in less than six minutes. The 222-hp. Kaelble six-cylinder diesel that powers all four wheels also drives the rudder-propeller unit, shown being lowered. Driver's cabin becomes the stern. A pilot stand on the roof is raised manually when the vehicle takes a dip. Water speed: eight m.p.h.



RAMP IS MOUNTED on same kind of vehicle, but is detachable. Once the ramp is anchored offshore and attached to bridge sections, its carrier vents its wheels to lose six inches of freeboard; carrier then is driven from under ramp and can be used for other operations.



BRIDGE SECTION is rotated and widened to 13 feet hydraulically. Unit then travels under its own power and attaches to the rest of the bridge. A powered raft for troop transport can also be formed by joining several bridge sections and two of the ramp units.

at 55 m.p.h.

A convoy of bulky, angular, khaki-colored vehicles bumps along open fields and rumbles up to a river bank.

Deflated pneumatic floats flap down along the sides, then swell bulbously. The vehicles drop clumsily into the water, and the wheels retract, turtle-like, into the hulls. Folded ramps atop the decks extend and swivel 90 degrees, and are secured in a long row by hydraulic lock pins.

Within a few hours a floating bridge spans the river.

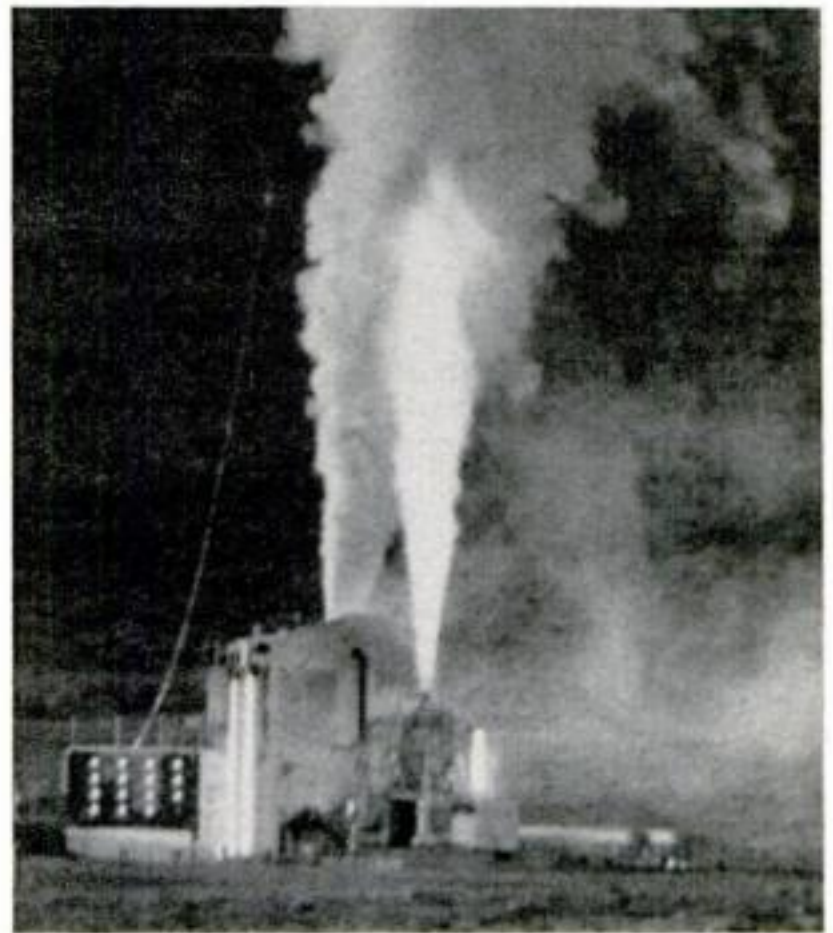
This fantastic river-crossing equipment may sound like the fanciful rambling of a daydreamer—but it actually exists today. And it works. Designed by a French military engineer, Colonel Gillois, it is being built for the French Army by a West German manufacturer.

The U. S. Army is also interested. Extensive testing in Germany by the 552nd Engineer Company has shown that the new mobile bridge can be assembled at over 400 feet per hour by 185 men. The currently used pontoon bridge takes far longer to set up, and requires a work force of 1,000 men, as well as scores of trucks to ferry the rubber pontoons and roadbed, and cranes to lower the pontoons into the water.

Another important advantage of the Gillois bridge is that it can be used over and over. After an attack column has crossed the river, the bridge can be dismantled quickly and scooted overland at up to 55 m.p.h. to meet the next water obstacle.—*Harry W. Stephens.*



ANCHORED RAMP UNIT (above, left) is connected to a bridge unit. Span is formed two halves at a time. The halves are then beached, ramp-first, and joined. Downward hydraulic pressure on the ramps steadies the bridge with help of propellers working against the current.



Test for rocket A-engine

Twin plumes shoot skyward in the photo above as Kiwi-A3, a forerunner of an atomic engine for a rocket, goes into action at the Atomic Energy Commission's Nevada test site. In the foreground, the nozzle of the barrel-shaped, uranium-fueled reactor, mounted upside down for tryout, spews aloft an A-heated jet of flaming hydrogen gas.

White column in background, from a smoke pot, helps sampling aircraft to follow the exhaust cloud and keep tabs on the spread of radioactivity it contains. Successful trial, third of a "Kiwi"-type or nonflying reactor, marks progress in developing materials able to withstand engine heat of thousands of degrees for an A-powered rocket expected to fly by 1965.



Limousine conversion

A detachable partition converts the British Rover three-liter sedan into a status-symbolizing limousine for business use. The wood frame with sliding glass panels attaches to the door pillars by spring-loaded plungers. Fillers on each side of the front seat complete the separation.



O'Sullivan's Wonderful Lead Balloon

His idea looked ridiculous; it failed seven times. And then it launched Echo I, the biggest and brightest satellite of them all

DESIGNER of successful Echo satellite, William J. O'Sullivan Jr., has followed novel precept: If a moon fails to orbit, build a bigger one.

OUTSHINING most stars, Echo I passes overhead in orbit. Pace is indicated by length of its bright trail in photo's 40-second exposure. Easily seen with unaided eye, Echo has given many their first thrilling look at a satellite sailing across sky. Its great 1,000-mile height kept it sunlit and visible all night at the season of its launching last August. Later, earth's shadow hid it much of night; now it's emerging from this "eclipse," which will end in the spring.



By Don Murray

ECHO I, the huge space balloon that, since last August, has been whizzing around the earth at 15,000 miles an hour, has proved a number of things. By bouncing radio signals back to earth it has demonstrated the feasibility of a new global telephone and television communications system using micro waves. By measuring for the first time the minute air density 1,000 miles above the earth, it has proved that our atmosphere still exists at that altitude. But more than anything else, by its very existence the space balloon has proved that old-fashioned stubborn perseverance is still a

most important element in a technological society.

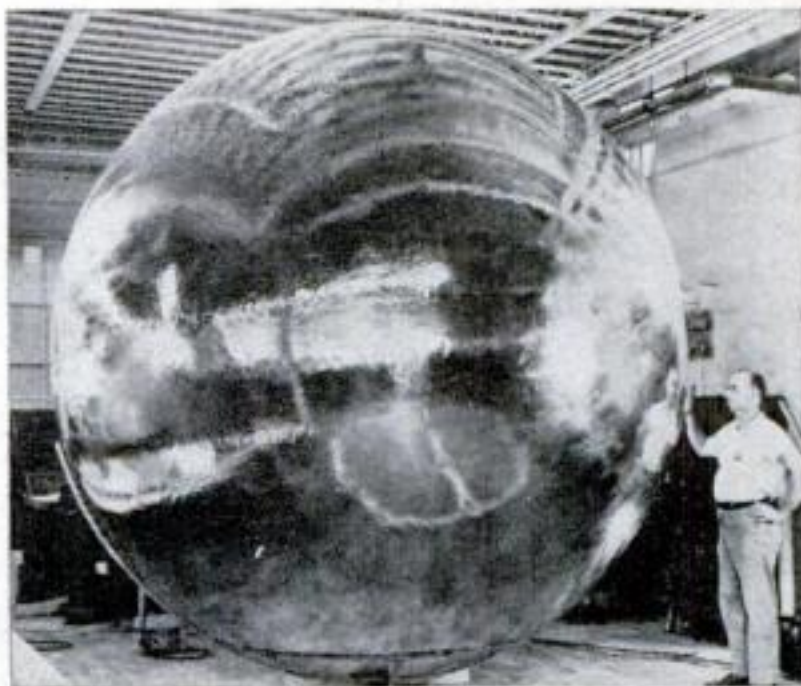
An employee of the National Aeronautics and Space Administration, 45-year-old, sandy-haired, chain-smoking William J. O'Sullivan Jr. didn't build Echo I by himself but for years it seemed as if he alone believed in it. This, however, in no way deterred him. He made the creation of inflatable structures in space a personal crusade. While others said the idea of space balloons was ridiculous, O'Sullivan heckled, harried, and hornswoggled both those who worked for him and those he worked for.

He went through channels, around channels, under channels, and even be-

Forerunners show how the Echo satellite grew



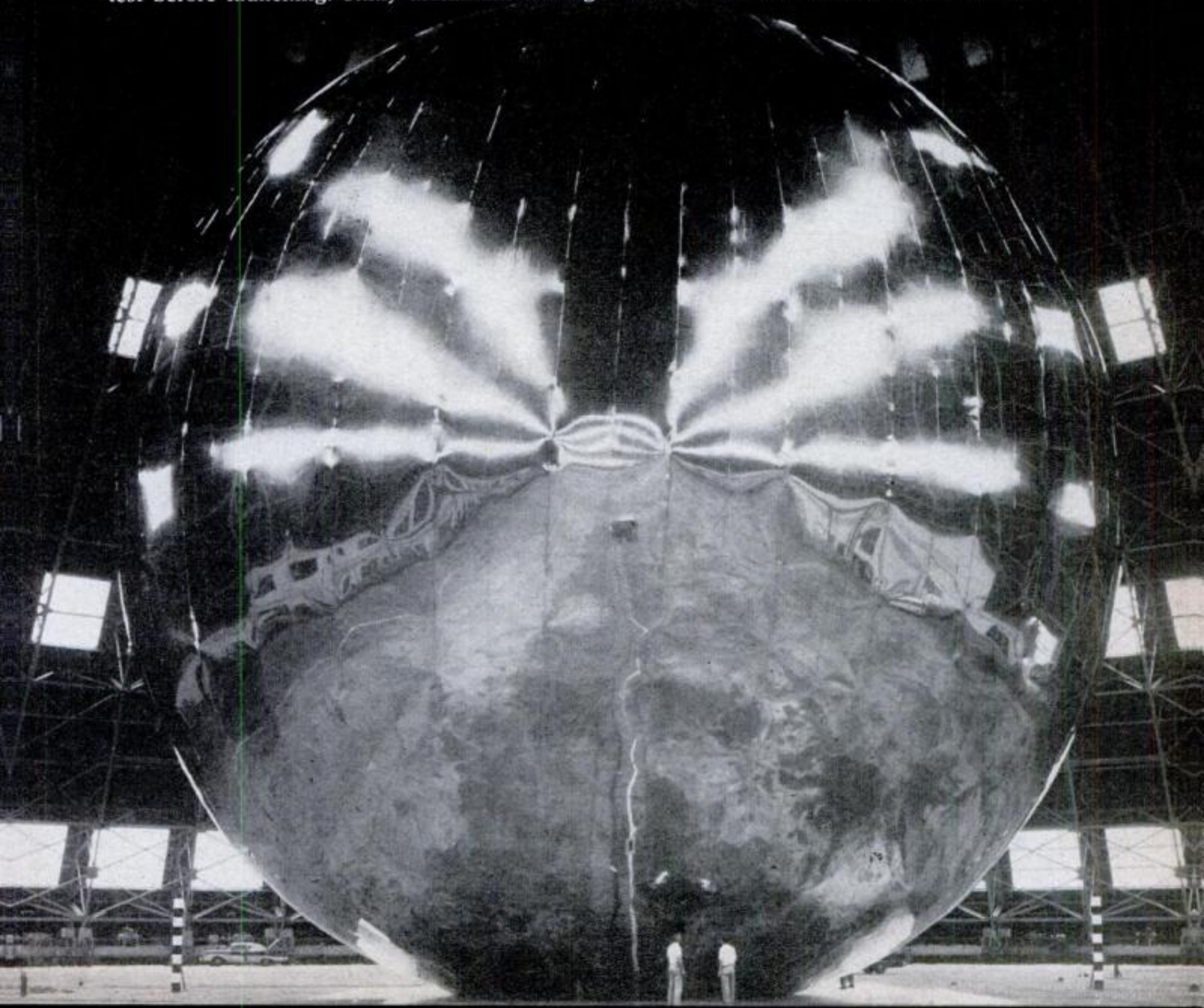
FIRST BALLOON SATELLITE, shown inflated and packaged, was 20-inch one. Similar 30-inch rode Vanguard rocket, got nowhere.



TWELVE-FOOTER came next. Two launching tries, with Jupiter C rocket and Juno II, both failed. Hundred-foot Echo followed.

TEN-STORY-HIGH, 100-foot Echo gets air-inflation test before launching. Shiny aluminum coating

for its plastic skin gives satellite high visibility and reflects radio waves back to earth.



Born as a research tool, balloon satellite becomes promising

yond channels to the White House itself, shepherding his crazy idea through years of discouragement as experiment after experiment failed—until that triumphant August day when millions upon millions of people looking heavenward in Europe, Asia, and North America saw Echo I curve gracefully from horizon to horizon.

New world in the sky. O'Sullivan has been looking heavenward since he was a boy in Kentucky. When he took his first plane ride in an open-cockpit plane at 18, he saw a vision of a new world in the sky to be conquered. At the worst of the depression he turned down a scholarship in archeology at the University of Kentucky "because I don't want to dig a hole in the ground, I want to dig a hole in the sky," and went to Notre Dame, where he earned all his expenses waiting on tables and repairing radios.

During his last semester, the University administration was shocked to discover that O'Sullivan had taken and passed so many courses that he was entitled to degrees in physics, another in aeronautical engineering, still others in mechanical, chemical, and civil engineering. Somewhere he had broken some rules and beaten the system, but you can't punish a boy for being smart. Nevertheless, O'Sullivan's dean called him in and told him he would have to spend several more years in residence to receive all the degrees; otherwise he could have only one. O'Sullivan chose aeronautical engineering.

After graduation, in the depression year of 1937, he considered himself fortunate but was amused when he got a job as an insurance actuary and put in some two years figuring fire-insurance rates for the entire state of Kentucky. Then he took Civil Service examinations in aeronautical and mechanical engineering, and landed a job at the national aeronautics research center at Langley Field, Va. He has been hurling himself at the advanced problems of planes, missiles, and space ever since.

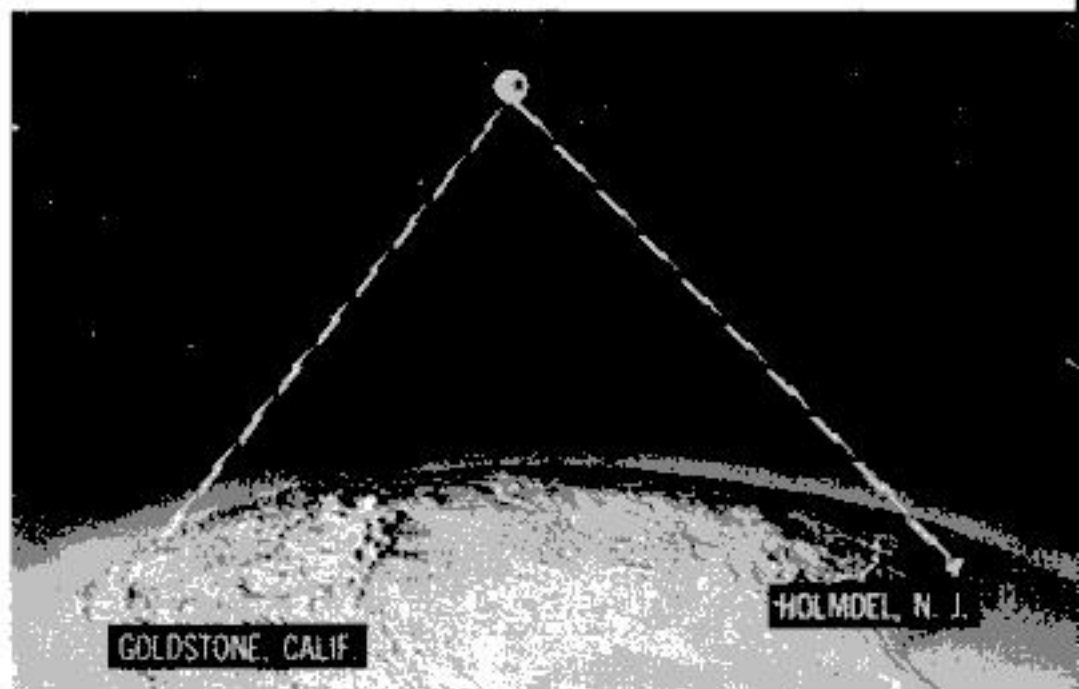
The problem of upper air. It was five years ago, while he was working with a committee of scientists in Ann Arbor, Mich., to choose the experiments to be attempted in space during the International Geophysical Year, that O'Sullivan

got his idea for a space balloon. All day long on Jan. 26, 1956, the committee considered ways of measuring the density of upper air. This was vital work. Accurate measurement of the thickness of the upper atmosphere would affect the course and design of every missile and satellite.

That night O'Sullivan couldn't let the problem rest. It seemed to him that none of the proposals seemed to attack the problem effectively. Technically, he was supposed just to judge the suggestions, not to make any of his own, but his brain itched to attack the problem. He yanked out a pad of white lined paper, gripped a pencil, and began a personal assault. He reasoned that if you heaved a large, light object into the air, which would be pushed around even by an infinitesimal amount of air, that then you could measure the push and figure out exactly how much air was in that part of the sky. But how on earth could you get a large object into space when our rockets had not yet orbited a grapefruit-size satellite?

His answers didn't come in a flash. They were the results of hours of muscular thought. O'Sullivan concentrated, sweating out all the combinations of facts that might provide the answer. He worked far harder than if he had been digging a ditch. He forced his experience, his knowledge, and his imagination to their limits.

After half the night he came up with a solution. Why not build a large satellite of thin material that could be folded in a nose cone and shot far above the earth



BOUNCED OFF ECHO, radioed voices, music, pictures span U.S. or ocean. "Passive" system takes high power, well-aimed antennas—but no electronic gear beyond servicing reach in space.

new aid to communication

to be expanded there, where the atmosphere is thin and would exert little pressure on it? It need not be of rigid metal, furthermore, since at the edge of space it would be able to support itself.

Like most really good ideas, this one was simple and obvious. It just hadn't been thought of before. O'Sullivan's hands raced over the paper. Build it of a metal foil, he thought, or a plastic covered with a metal, perhaps lead, which wouldn't be affected by solar radiation.

The lead balloon. O'Sullivan flung himself into bed exhausted, but filled with the satisfaction of a job well done. He couldn't sleep, however. He worried about what his fellow scientists would think of his proposal. He spoke aloud, "It will probably go over like a lead balloon!" and sat up in bed. That was just what he was proposing, wasn't it? Why not lead?

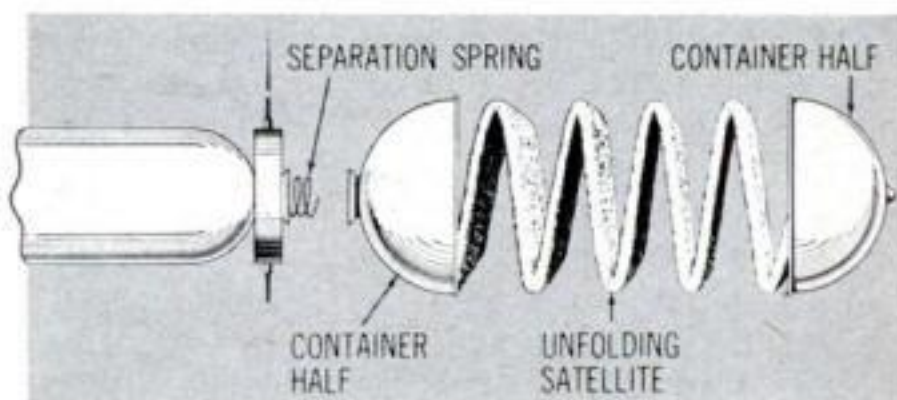
The next day some of the experts who studied his suggestion were dubious about putting a big bubble in the sky, but others saw its possibilities. There was another problem, however. Experiments with more priority had taken up the relatively tiny area at the top of a Vanguard. There was only a little doughnut of room left over. Could he pack his balloon in there? And could he make it weigh no more than seven-tenths of a pound? He puffed at a cigarette, then nervously rubbed it out. He'd try that, too.

O'Sullivan was off on another crusade. Back at Langley he politicked his superiors into supporting his work, picked a team, and got to work. They tested a hundred plastic and metal foils. The satellite skin would have to be thin, flexible enough to be folded, and yet so tough that it would not tear apart when it was exploded into a sphere. It would have to be rigid when it was inflated. And there was the problem of temperature. The satellite would be outside the protection of the lower atmosphere, and the temperature of sunlight on its surface would be at least 300 degrees Fahrenheit. Minutes later it would whirl into the shadow of the earth, where it would suddenly be cold—at least 80 degrees below zero. What plastic could stand that?

They found the answer—Du Pont Mylar, a plastic used for recording tape, and



IN THE MAKING, 100-foot satellite is assembled by fitting and cementing gores of plastic. Folded and packed into a metal sphere, it is then boosted by rocket into orbit.



IN SPACE, halves of spring-nudged sphere come apart and balloon unfolds. Self-inflating, it contains a powdered chemical, anthraquinone, that turns directly from a solid into a gas.

for those bags filled with frozen food that you can take out of the freezer and put directly into hot water. It had a tensile strength of 15,000 pounds per square inch, one-third that of mild steel, even when it was manufactured in sheets only .0005 inch thick, half as thick as a cellophane wrapper on a pack of cigarettes.

All right, that's solved, now how about the covering? Some metal would have to protect the satellite against radiation, help it keep its shape, and also make it visible to radar scanners. Metal after metal was tested and ways tried to paint

[Continued on page 220]



OPEN WIDE. Big Boy, good-natured 11-year-old gorilla at left, takes vitamins from spoon extended through bars by zoo's Dr. Byron Bernard.



GO AWAY, BAD MAN. Young chimp remembers shots Dr. Bernard gave with needle. He's friendly with keepers, but he doesn't like the doctor.

Zoo Doctor Treats Dangerous Patients

A veterinarian caring for animals in a zoo has an often exciting and hazardous occupation. Once, a 4½-ton elephant suffered a fatal heart attack and narrowly missed falling on Dr. Byron Bernard, who was treating him at the Cincinnati Zoological Gardens. On another occasion he was grabbed through the bars of a cage by an enraged chimpanzee and could have lost an arm or his life if four keepers hadn't been nearby to beat off the animal. Chimpanzees, the doctor believes,

are the most dangerous creatures he's called upon to treat. They remember and resent the sting of medical shots, and become difficult to handle with age.

Most of the zoo doctor's work is preventive medicine, feeding his charges balanced diets, keeping them in condition, and watching newly shipped animals during a quarantine period. Dr. Bernard has also splinted the leg of an ostrich, which has a thighbone as big as a horse's; trimmed the teeth of a hippopotamus;



EASILY HANDLED by zoo's expert reptile men, this python is hard to keep healthy. Parasites prey on snakes; proper environment is a problem.



TIME TO PLAY. Dr. Bernard's young daughter, in nurse's uniform, fondles two six-week-old lion cubs. They'll soon be too big for this kind of play.



OIL FOR THE RHINO is applied from an oilcan by a zoo attendant. The horn has to be oiled once a week to keep it sleek and healthy.



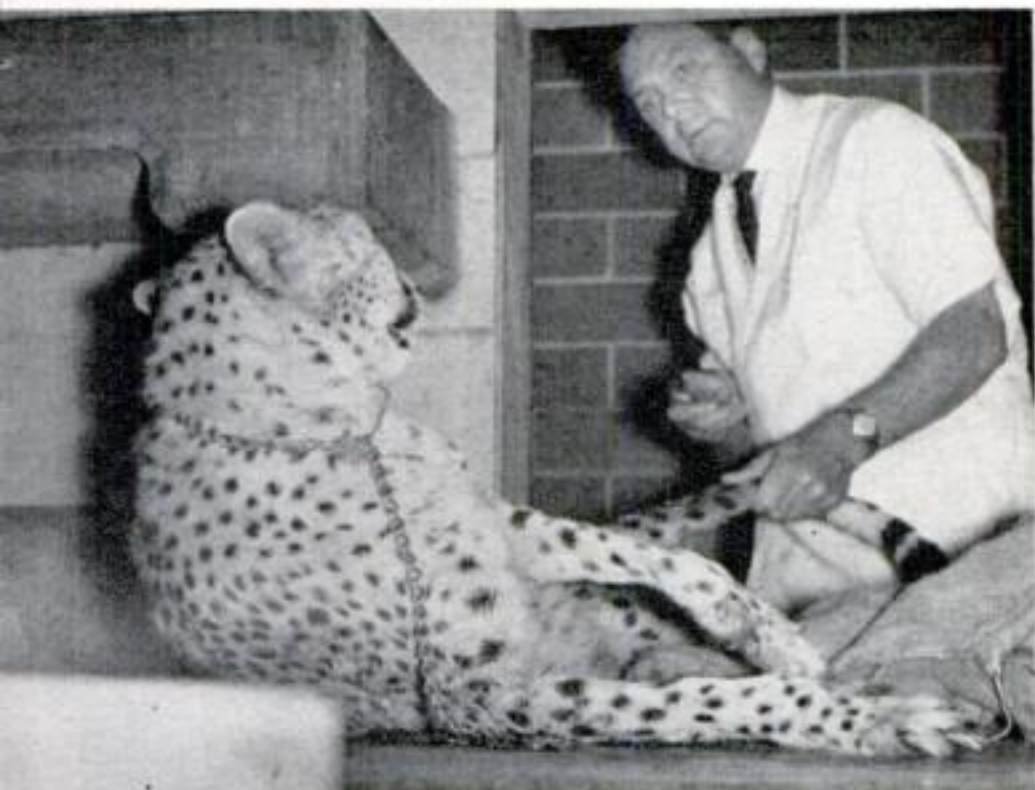
SQUEEZE-CAGE, cranked to narrow slot with screw (above), crowds this hyena so he can't bite or claw when the veterinarian administers his medication.



OH, SO SICK, and Sheeba, the tiger, looks it. Ordinarily easy to get along with, she has to be put into a squeeze cage for treatment.

operated successfully on a black leopard to remove a cancer; and pulled the aching tooth of a tiger, a two-hour task.

He never knows what his next job will be. He is in charge of 2,200 patients, and anything can happen to one or more of them at any time—and it usually does.



CHEETAH HELD BY THE TAIL could claw Dr. Bernard seriously, but this one was so sick that he couldn't stand up, let alone strike out.



Remote-controlled subway

The world's first fully automated train, a three-car subway, soon will be shuttling passengers between Times Square and Grand Central Station in New York. Automatic wayside dispatchers transmit electronic impulses via the rails to a receiver coil mounted on the train's undercarriage. Six code-carrying circuits in the rails control starting, speed, brakes, doors, lights, and destination signs.

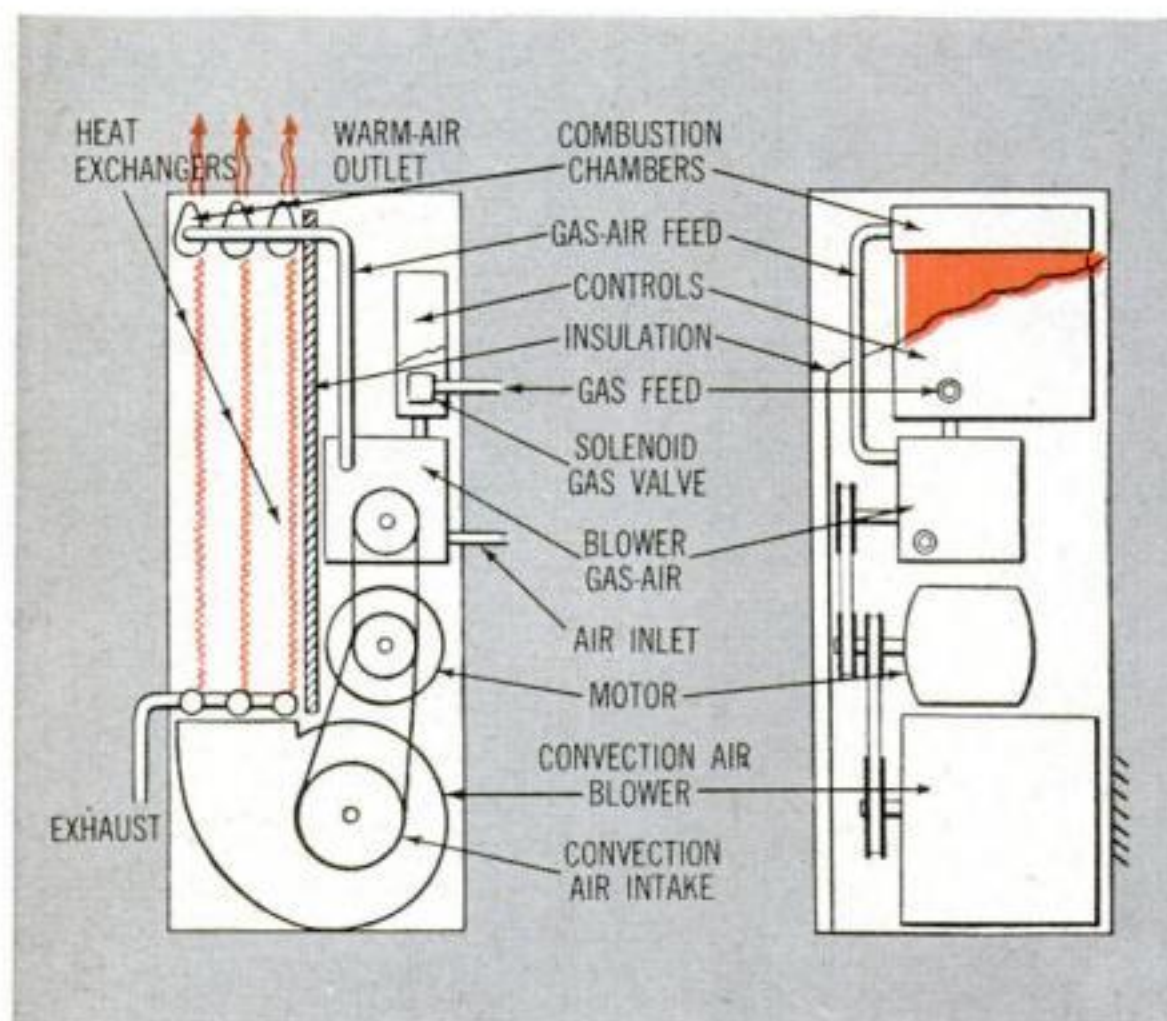


Flexible gasoline can

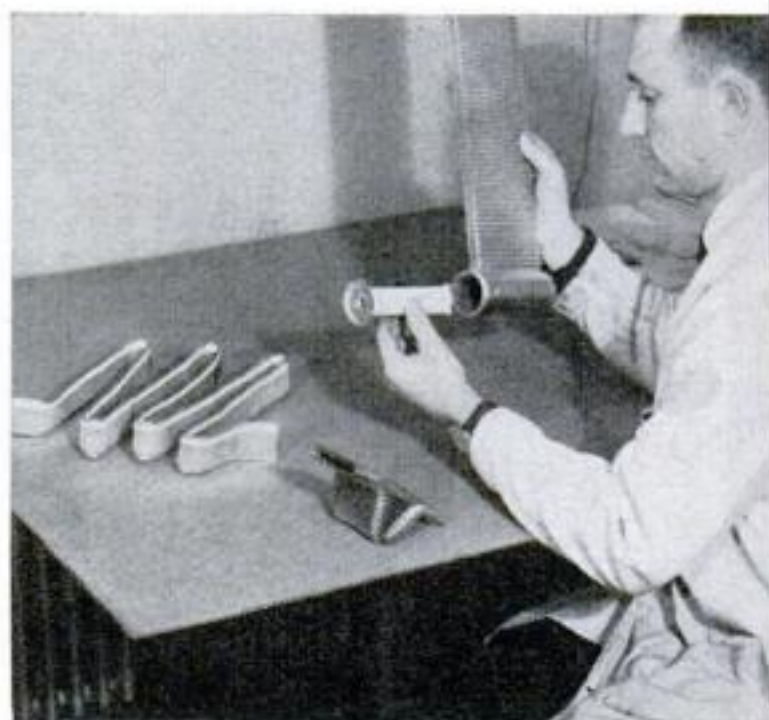
You can carry this emergency gasoline container in the trunk without rattle. It holds four gallons and is made of nylon fabric impregnated with oil-resistant synthetic rubber.

The British-made bag collapses as the gas is poured, thus eliminating air lock. It weighs 1½ pounds when empty and can be rolled into a tight bundle for storing away easily.

New Gas Furnaces Glow, Pulse, Even Burn Without Flame



WARM-AIR FURNACE designed by American Thermocatalytic Corp. is a chimneyless, compact unit with 100,000 BTU-per-hour output. Heat is supplied by three radiant cores (at top).



HEAT EXCHANGERS get streamlined. Slim strips of finned stainless steel will be used in the warm-air furnace at left. Lightweight and flexible, the flat tubing costs less and will deliver more heat than conventional heat exchangers. Here a lab technician holds a sample with built-in hollow chamber to house a small Pyrocore reactor.

By Joan Steen

QUESTION: What do these four things have in common?

- A slim object, very like a fluorescent tube, that glows with a slightly mildewed yellow color.

- A pulsing mechanism that's a tamed version of a World War II buzz bomb.

- A cannibal-styled rig that feeds back some of its heat to power a fan.

- A hunk of ceramic hung outdoors that could make swimming pools year-round diversions.

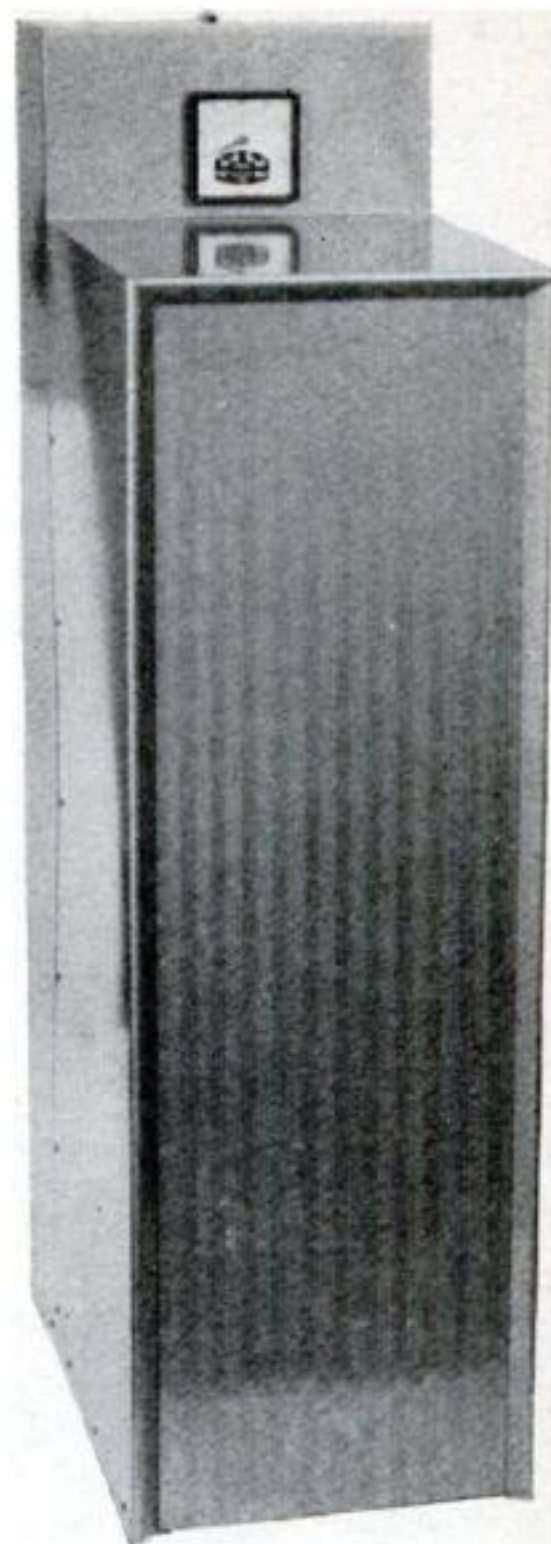
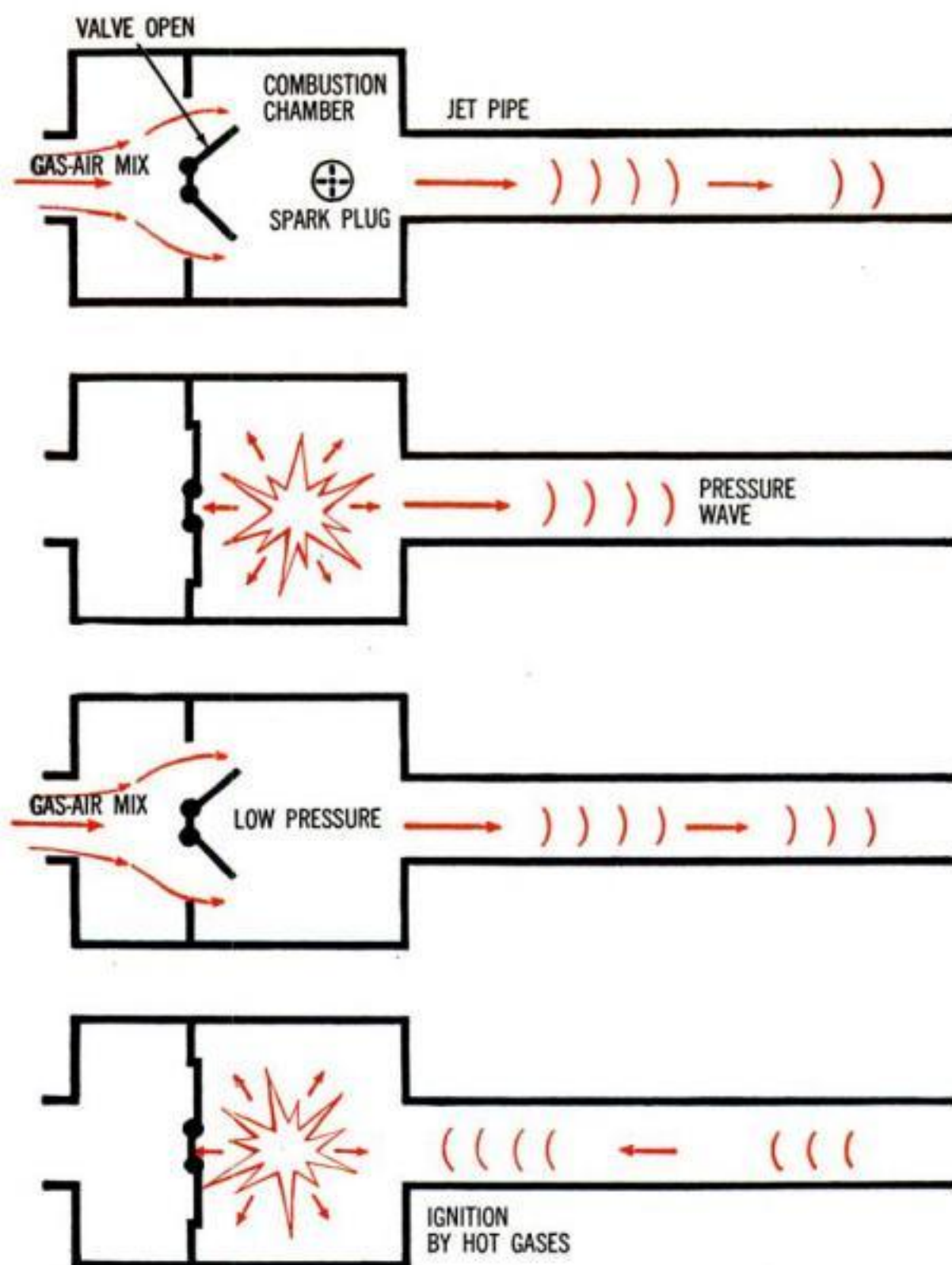
Answer: They're all furnaces.

What's more, they're all gas-fired, all new, all promising to deliver the last drop of heat from Scrooge-like portions of fuel.

Gas-appliance manufacturers, out to top competitors pushing electrical and

oil systems, have had to come up with heat in tidier packages. They've streamlined conventional systems into smaller, chimneyless, sealed combustion units. New ones, some still only prototypes, will include these features, as well as completely revamped burners. While they may cost more, their promise of close to 100-percent efficiency compared to 60 or 70 percent for conventional systems will save you money in the long run.

Flameless heat. The most radical of the new burners is the one with the fluorescent-tube look—the "Pyrocore" reactor developed by American Thermocatalytic Corp., Mineola, N. Y. The reactor radiates heat like a small sun, glowing at almost 2,000 degrees F. seconds after it's turned on. But the reactor is no ordinary burner. It uses catalysts—substances accelerating a chemical change



BUZZ-BOMB INSPIRED, this is the new Lucas-Rotax boiler. The first mix of fuel is spark-ignited. Expanded hot gas moves out into the

jet tube leaving a low-pressure area behind it. As a second mix of fuel is forced in, some of the outgoing gas returns to ignite it.

while they themselves stay out of it—to maintain combustion once it has been started.

These special catalysts are imbedded in the porous reactor tube. When a gas-air mix under slight pressure is fed into the tube, it is at first ignited electrically. As the mix heats and expands, it squeezes through the tube pores, making the surface incandescent (at about 2,000 degrees F.) and radiating heat outward. But some of the heat feeds back to the catalysts. These in turn stir up the gas and air so that they combine with the intensity necessary to maintain the ultra-high surface temperature.

The Pyrocore can be used directly in open air or, properly encased, as a space heater. It can be sheathed in metal and hooked up to a secondary heat exchanger for a hot-air or hot-water system.

Vented applications need no chimney. The exhaust may be pumped directly outside. Since Thermocatalytic combustion is near perfect the exhaust is exceptionally clean—no soot.

So far the company has been a supplier to industry rather than to the general public. It makes basic Pyrocore reactors in modular units along with a growing list of components: power packs, blowers, heat exchangers, etc., to be assembled as desired.

But the hint is that soon they will have available a warm-air central system for house heating. While they are not ready to take orders yet, they promise that the heater will take up less than half the space of comparable systems, furnish 100,000 BTU at very high efficiency, and use a novel heat exchanger—a flexible finned strip of stainless steel,

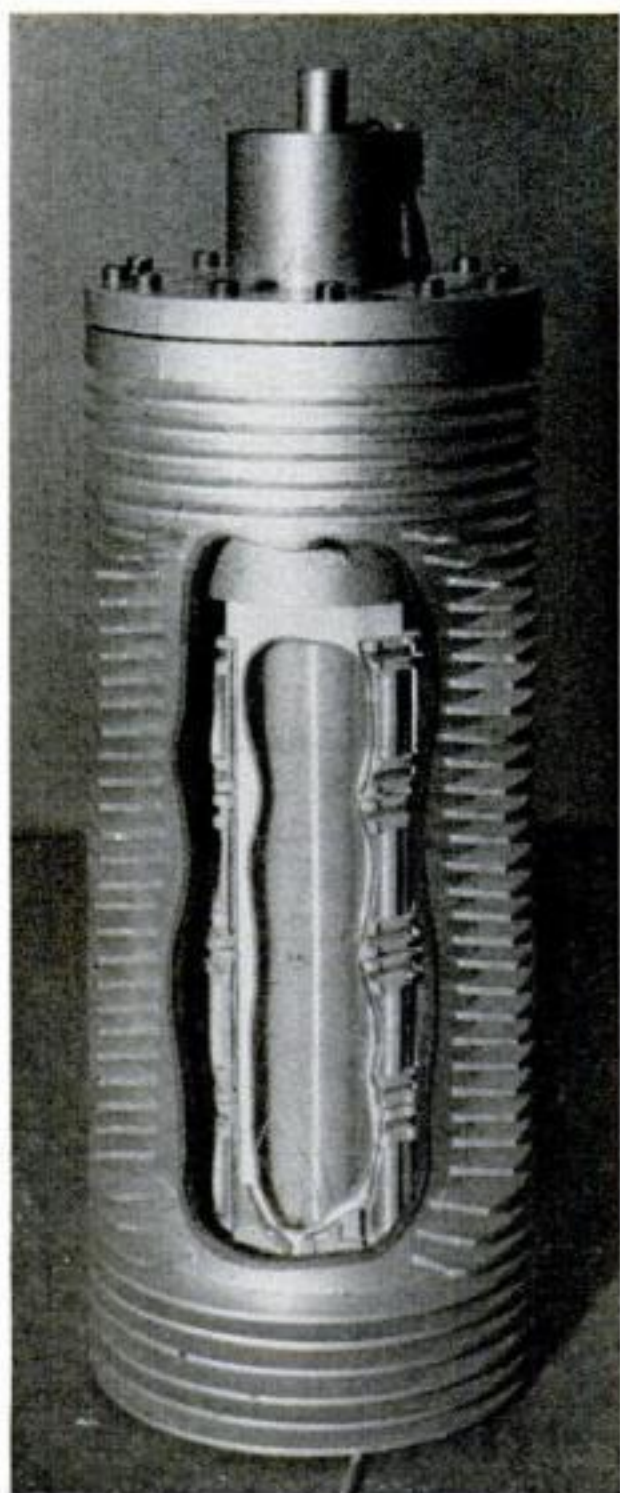


A SNOW-FREE ISLAND in the sun—or the simulated sun produced by a set of Schwank Infra-Red heaters overhead. Incandescent ceramic walls lining each unit emit infrared rays.

compact and lightweight. Best news is the system's cost—it will match conventional systems in the medium-price range.

Pulse heat. One central-heating, hot-water system already on the market is Pulsamatic—the heater patterned after a buzz bomb. Developed in Canada by Lucas-Rotax, of Toronto, the small unit (only four cubic feet) is another radical departure from conventional ways of burning fuel. A small-diameter plastic hose takes in outside air and feeds it with a measured amount of gas into a sealed combustion chamber. The first charge is ignited electrically, and expanding hot gas moves out in a pressure wave into a jet tube. A second helping of fuel now is forced into the low-pressure chamber and some of the outgoing hot gases rush back to ignite it. In this way heat pumps its way through the jet tube in short fast pulses—70 cycles a second. A muffler quiets the pressure-wave noise.

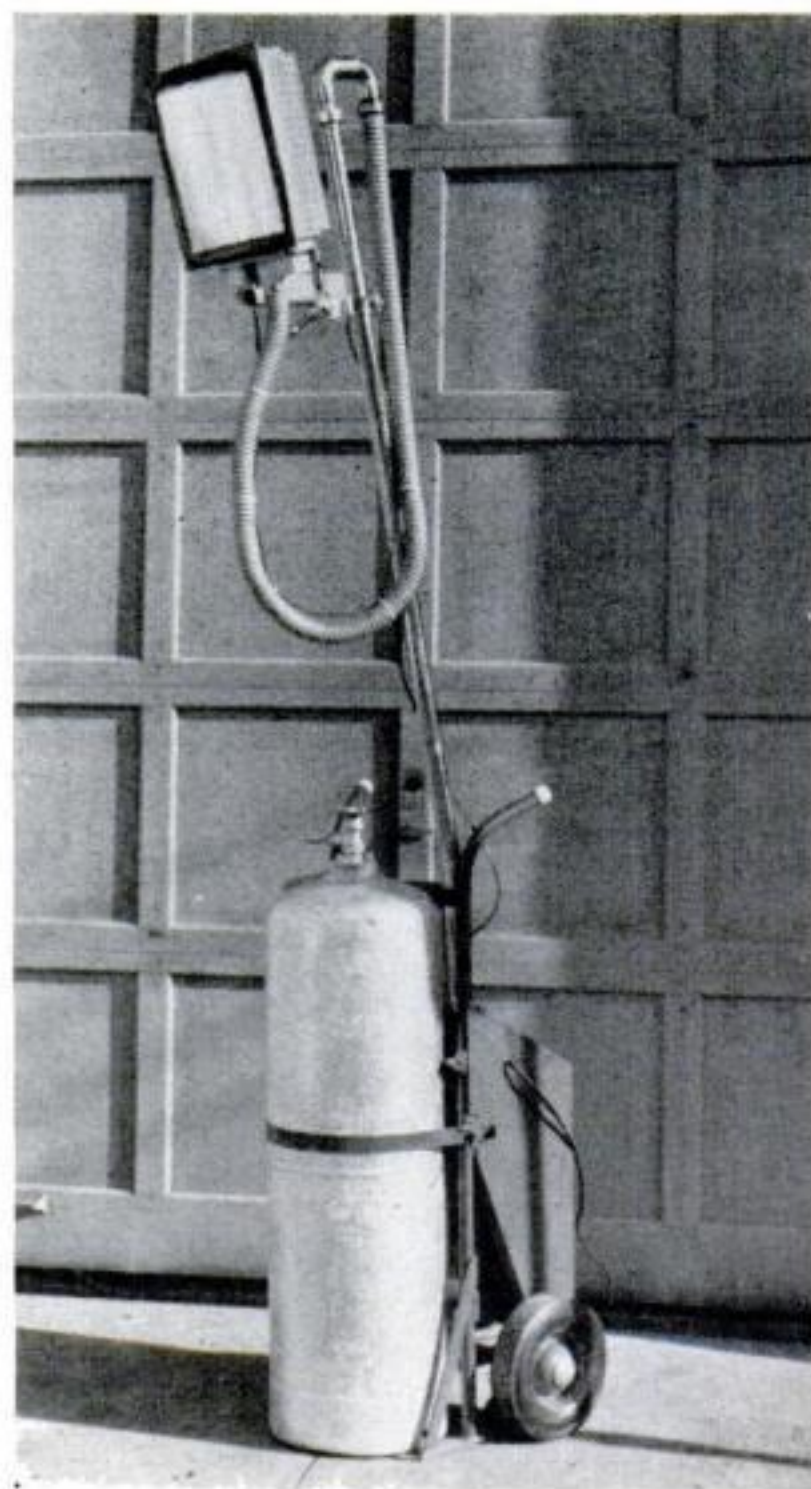
There is no open flame, no need for chimney or wide draft vents, and since no inside air is used, there are no chilly

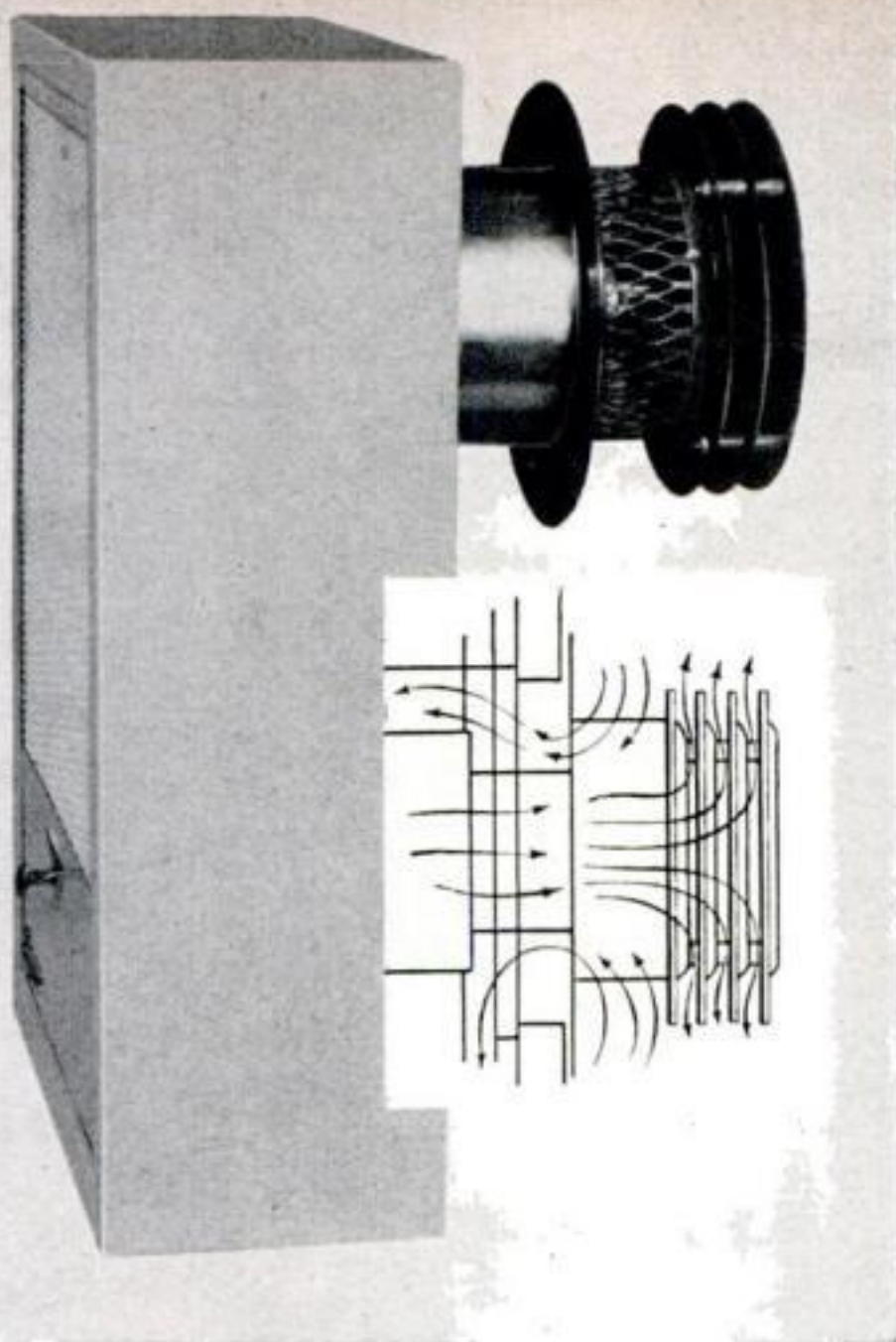


THERMIONIC GENERATOR

offers one way to convert heat directly to electricity. Electrons are "boiled" off metal plate and then collected on acceptor plate a hair's-breadth away. The gas-fired converter shown in cutaway model was developed by Thermo-Electron Engineering Corp., Cambridge, Mass. Need for space-vehicle converters is spurring research.

REALLY PORTABLE, radiant heater run on bottled gas is shown set up for driveway use. The screened-in box at the top houses one of American Thermo-catalytic Corp.'s Pyrocore reactors. The hollow tube—a refractory material imbedded with catalysts—heats to surface temperature of 2,000 degrees F. or better. But there's no flame. It can't be blown out in a high wind.



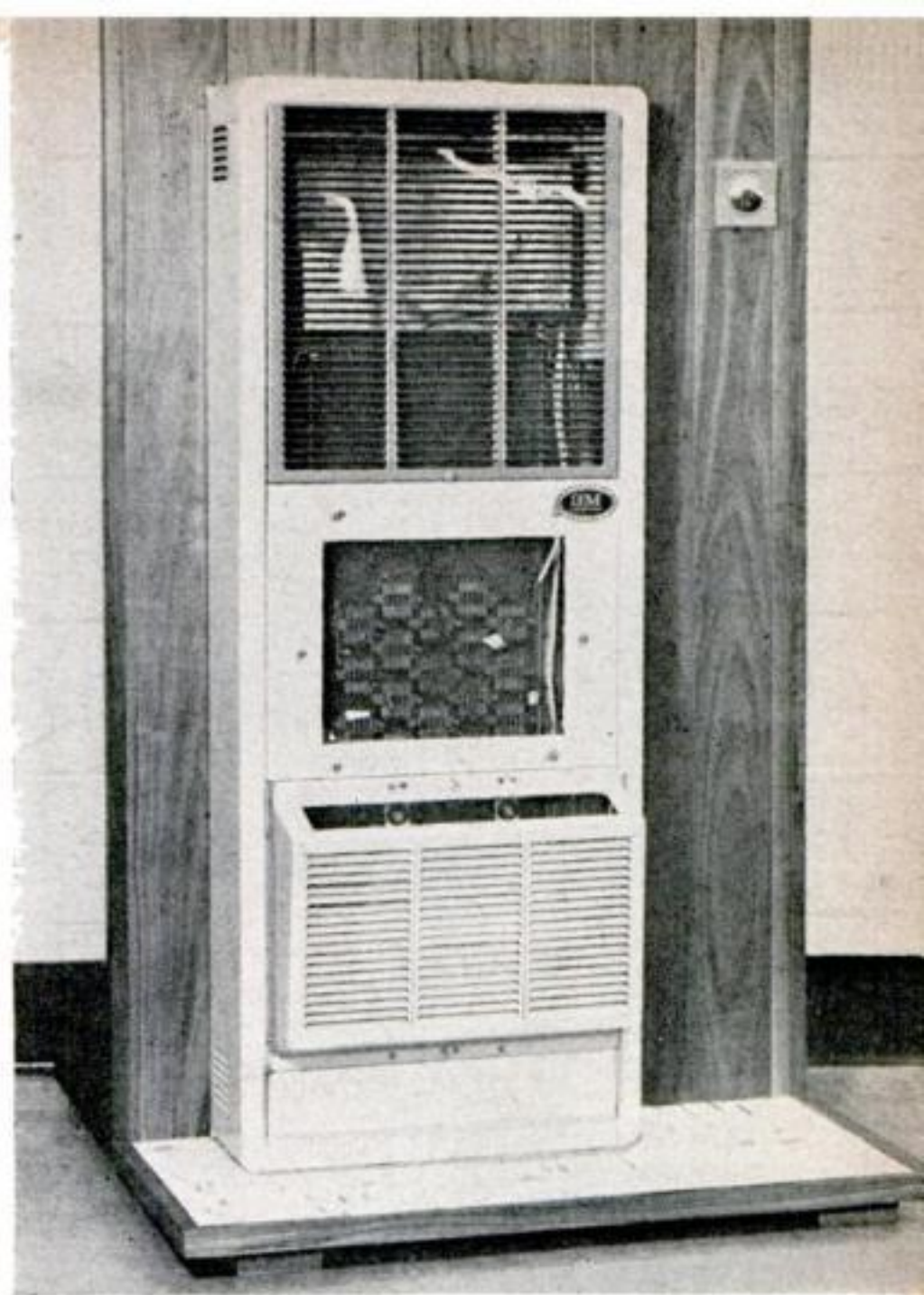


CHIMNEYLESS HEATERS made by Empire Stove feed intake and exhaust vents directly outside. Incoming fresh air circulates around exhaust and cools it. Model shown is two feet high, 16 inches wide. It can be recessed in place.

inside drafts. Again the exhaust is clean and the efficiency high—on two counts. One is the greater heat transfer possible with a pulsing flow of gas. The other is the unusually low exhaust temperature—lower than the dew point. Water vapor is condensed to avoid heat loss. The result is an efficiency rated at 90 percent. Output is 100,000 BTU an hour.

Thermoelectricity. Two “cannibal” furnaces—they feed back a little of their heat to run fans and blowers—are in the prototype stage. One is a wall heater designed by Minnesota Mining and Manufacturing, the people who make Scotch Tape. The trick here was to build in a bank of thermocouples above the furnace chamber. It takes very little heat to set the dissimilar metals of each thermocouple to making electricity. A bank of them can generate enough current to power a warm-air circulating fan as well as operate the temperature controls.

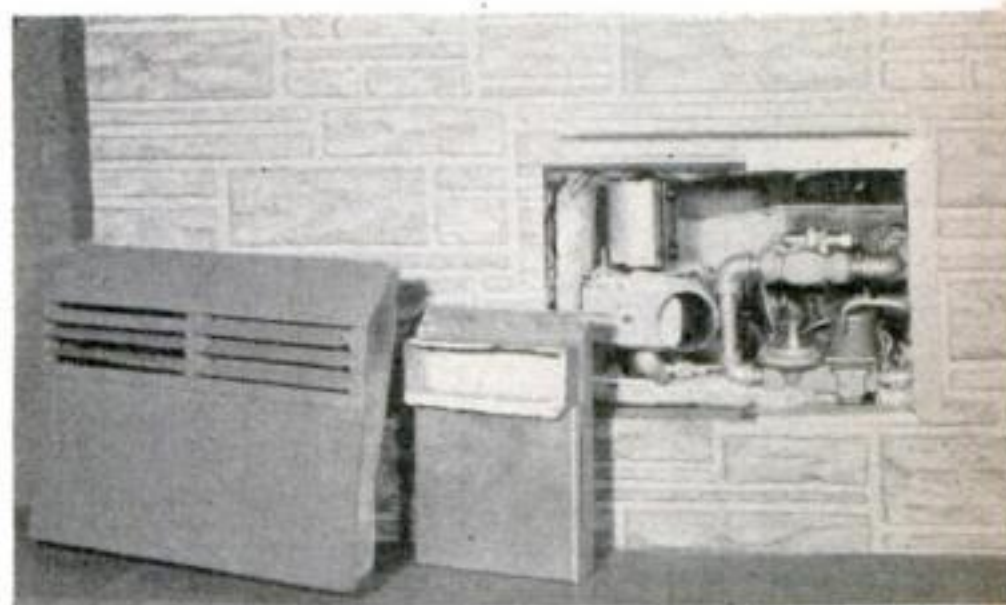
The second thermoelectric system is smaller—a bathroom heater developed by



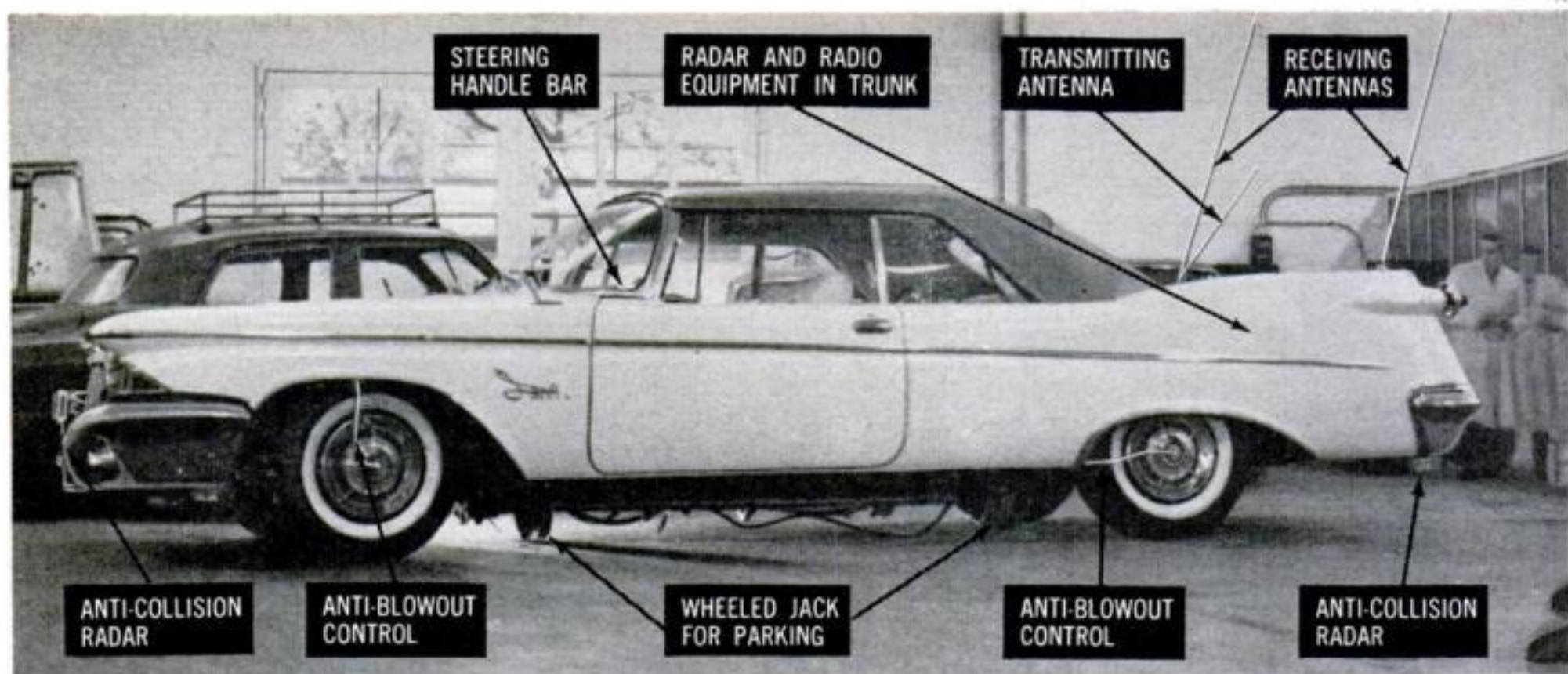
GAS HEATER MAKES ITS OWN ELECTRICITY: A bank of thermocouples in the center of this wall heater developed by Minnesota Mining and Manufacturing makes enough juice to power the warm-air circulating fan and the controls.

the Lone Star Gas Co., Dallas, Tex. It fits neatly into the ceiling and uses a gas-fueled radiant burner for its heat source. A series of 42 thermocouples generates about 1½ watts—enough to power the air-handling fan and, again, operate the automatic controls.

[Continued on page 212]



GAS-FIRED BASEBOARD HEATER feeds an eight-foot tongue of flame through a stainless-steel tube. A direct-vent heater, here's how it looks fitted into an outside wall of a house.



Miracle car has built-in radar and radio controls that make it crashproof and burglarproof.

A car that refuses to get into a collision

This Imperial Crown convertible boasts accessories Chrysler doesn't offer. They were built in by a Belgian garageman, Alphonse De Joncker, who picked up some of his ideas while in the U. S. Army during World War II and as a volunteer ambulance driver since for his local Red Cross in Courtrai. Here are some of them:

- Anti-collision radar front and back eases up on gas and applies brakes if the

driver nears an unseen object—particularly useful for driving in fog.

- Automatic controls on each tire warn of air leaks and, in a blowout, disengage brakes on the affected wheel.

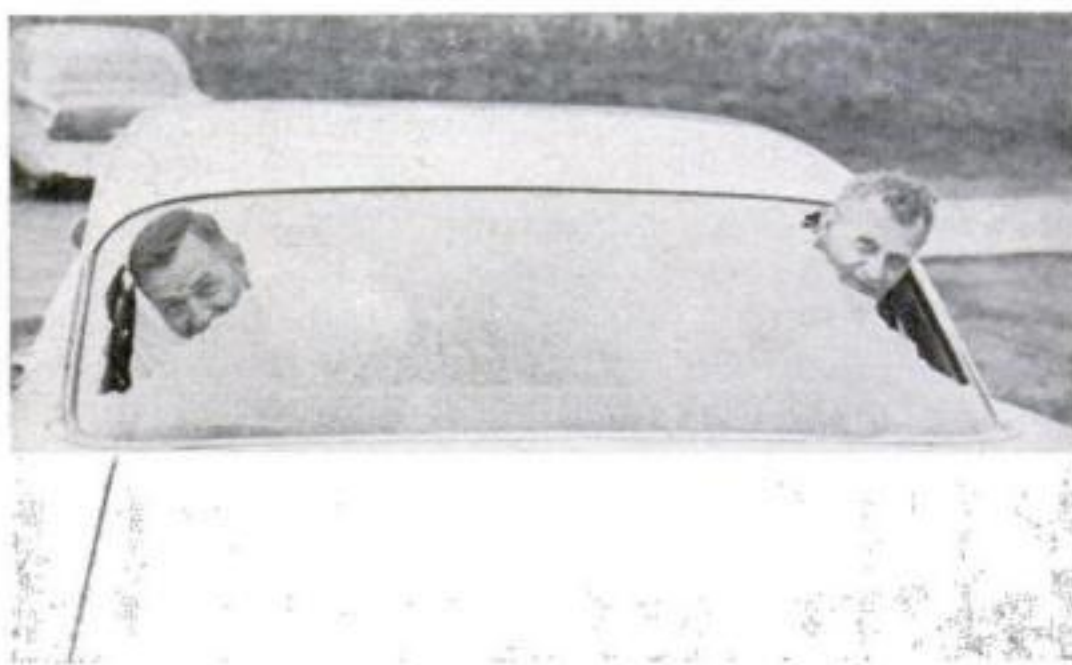
- Motorcycle handle bar with accelerator and brake controls in grips replaces steering wheel, eliminating pedals.

- Motorized caster wheels raised and lowered by hydraulic jacks get the car



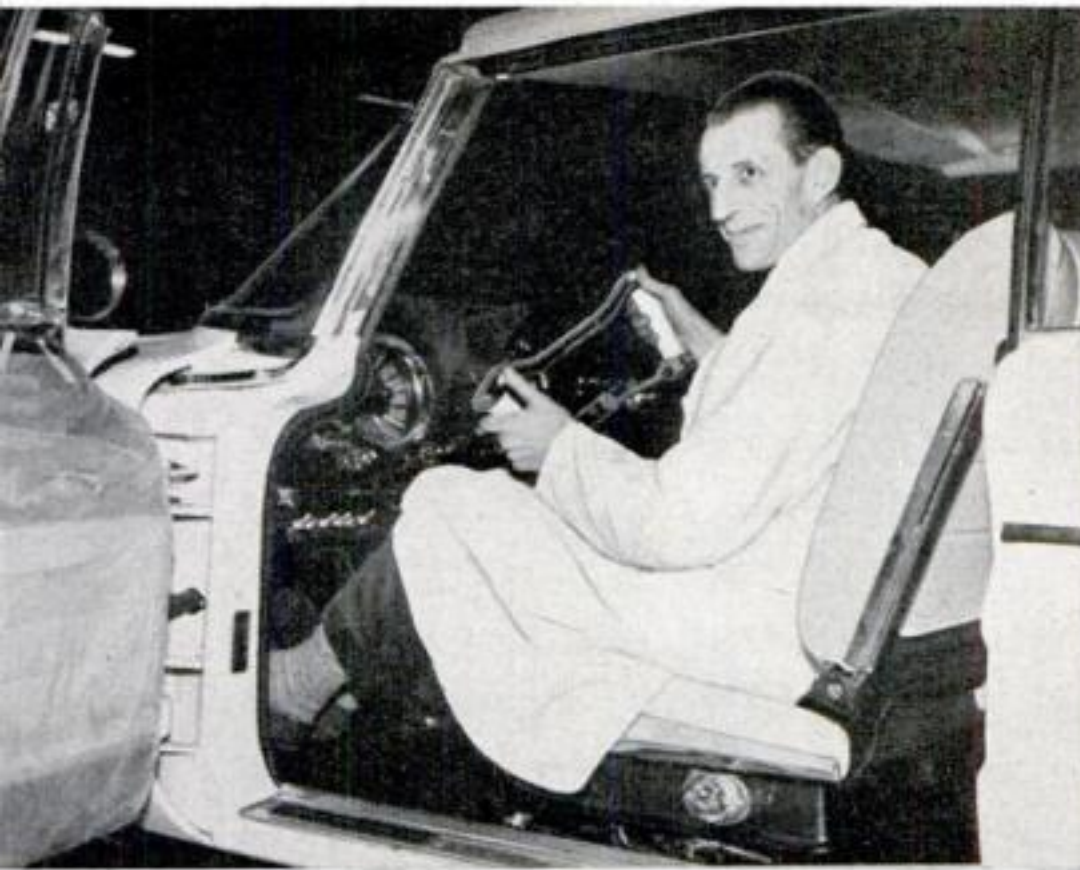
Motorized grape picker

A grape harvester that can gather up to five tons of grapes an hour has been developed by Cornell University researchers. The gasoline-powered machine, which is operated by two men, shakes the grapes off the vines with vibrating flaps that look like a paddle wheel. A conveyor carries the grapes back to a receptacle.

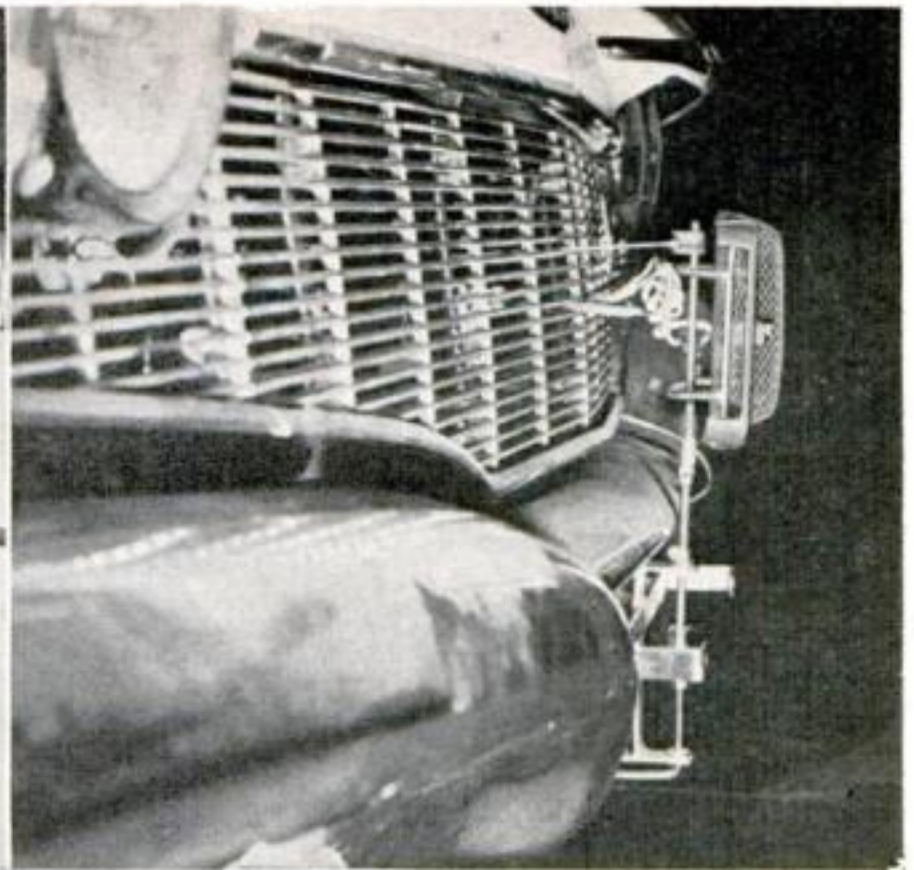


Storm shatters car window

It pays to leave a window in your car open a crack when locking up, as these motorists can attest. When a sudden storm hit Atlanta, Ga., recently and the temperature dropped 20 degrees within an hour, the rear window in this tightly sealed car shattered. Five other automobiles in the area suffered a similar fate.



HANDLE-BAR GRIPS twist for acceleration. Pulling on them applies car's brakes.

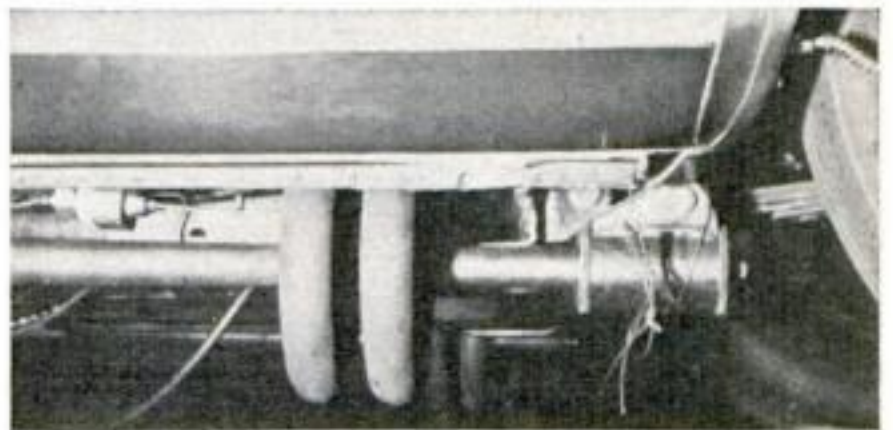


ANTI-COLLISION RADAR, set for any distance, halts car on approaching an unseen object.

sideways into and out of parking spaces.

- Radio controls open the garage door and, when he is far from home, let him start the house furnace, turn on the house lights, and talk with visitors who press the doorbell at his home.

- To protect his considerable investment, De Joncker has installed a burglar alarm that sounds when an unauthorized person gets into the driver's seat. The car can also be stopped by a spoken radio command within a radius of 2,000 feet.

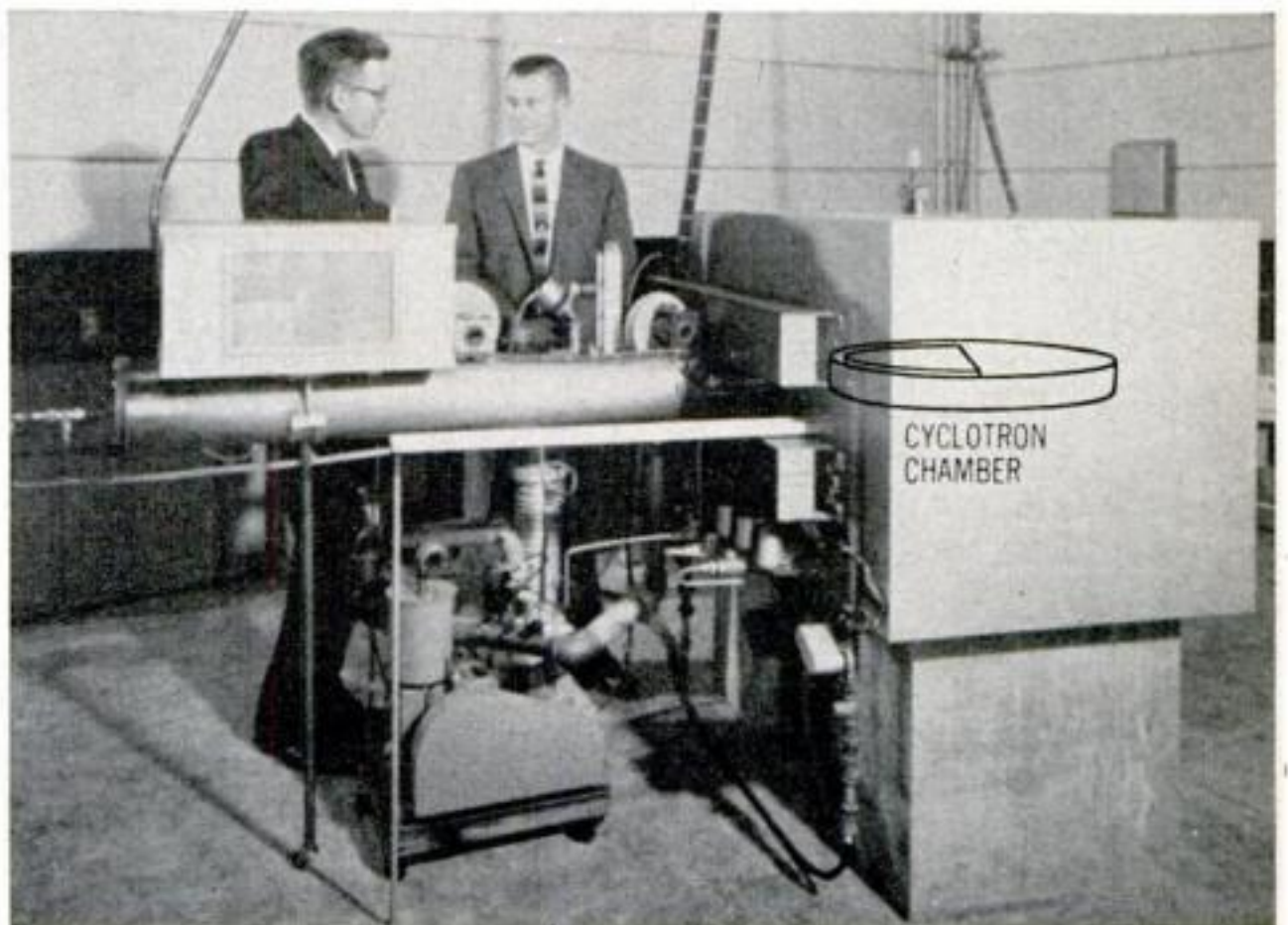


HYDRAULIC JACKS, fitted with wheels run by their own motor, park the car sideways.

Students get atom smasher

Undergraduates learn nuclear alchemy at Pomona College, Claremont, Calif., with a cyclotron designed and maintained specially for their use.

Into the desk-size atom smasher, built by Hughes Aircraft Co., go a stream of hydrogen gas and some 11 kilowatts of electric power. Hydrogen ions are shot into a disk-shaped chamber and whirled to generate a 2,000,000-electron-volt proton beam that bombards targets inserted through a vacuum valve. By exposing materials to this atomic whammy, students can make



them artificially radioactive and transmute one element into another. What's inside the box is sketched on the photo.

POPULAR SCIENCE here presents the second of three articles on Detroit's new compact cars for 1961.

Last month we related our staff experiences with an Oldsmobile F-85 in 10,000 miles of driving. This month we report on 10,000 miles in a Pontiac Tempest, a year's average driving compressed into one month. In less than 30 days, we drove the Tempest through 17 states and two Canadian provinces, in heavy traffic and on deserted lanes.

Like the Corvair, Falcon, and Valiant that we tested last year, and the F-85 last month, the Tempest was bought at full retail price. It was a manual-shift station wagon, with only a heater, radio, and outside rear-view mirror as accessories. The engine, Pontiac's tameest, was a cast-iron four rated at 110 hp. with 8.6:1 compression and a one-barrel carburetor.

Next month: 10,000 miles in a Dodge Lancer.

Testing the New Little Pontiac:

10,000 Miles in a

By Devon Francis

HOW THE TEMPEST DID



THE PERFORMANCE

Total distance covered	10,498 miles
Gasoline used (non-premium)	518.2 gal.
Average miles per gallon	20.25
Oil burned	1 qt.
Gas mileage at constant speeds	
30 m.p.h.	28.4
40 m.p.h.	27
50 m.p.h.	24.9
60 m.p.h.	22
Gas mileage in stop-and-go driving	18.7
Acceleration	
0-60 m.p.h.	13.5 seconds
40-60 m.p.h.	7.9 seconds
50-70 m.p.h.	9 seconds

Top speed 96-plus m.p.h.
Speedometer error

Indicated Speed	Actual Speed
40 m.p.h.	37.5 m.p.h.
50 m.p.h.	47 m.p.h.
60 m.p.h.	57 m.p.h.
70 m.p.h.	67 m.p.h.

THE COSTS

Gasoline	\$171.06
Oil burned	.50
Gas-oil cost per mile	.0163
Repair and maintenance, including adjustments at 500, 1,000, 5,000, and 10,000 miles	
Oil and filter changes	\$10.44
Lubrication (including draining and refilling transmission)	12.00
Total labor	1.20
Total	23.64
Overall direct operating cost per mile	.0186

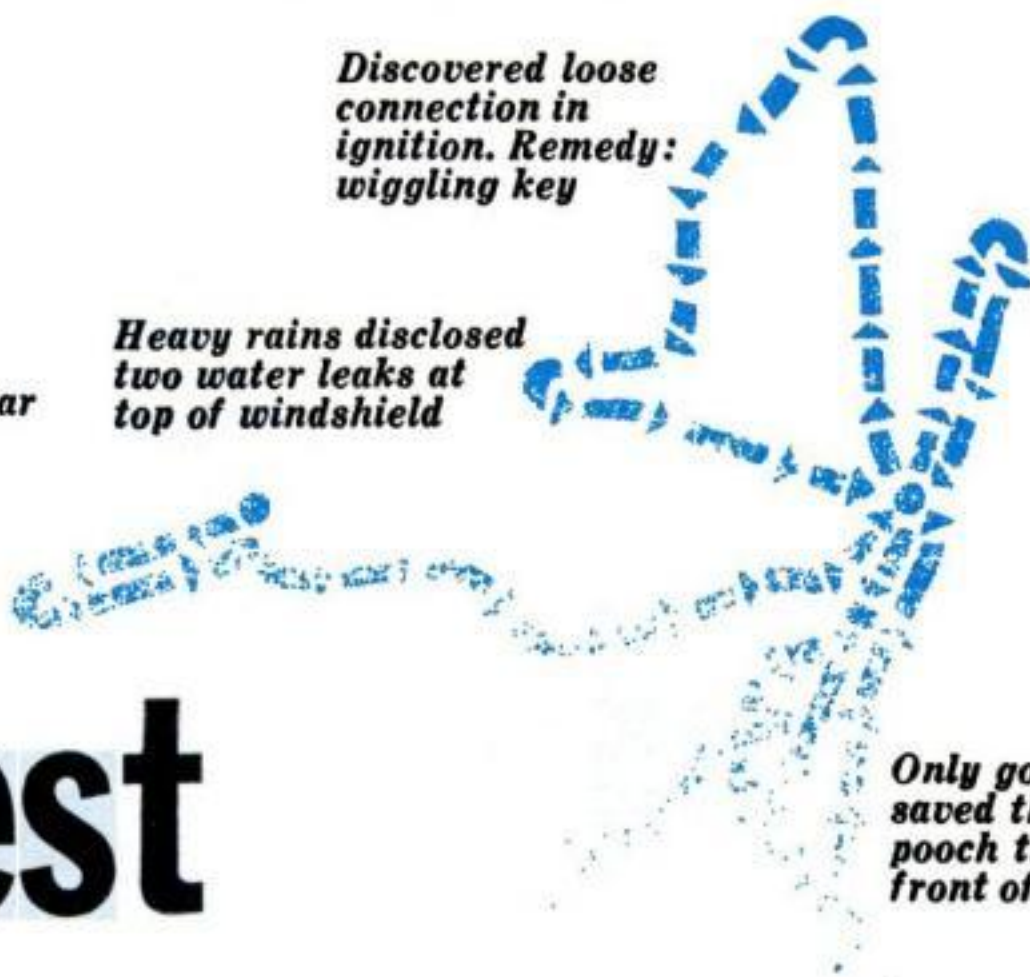
*Popular Science
Tempest had racked up
2,900 miles by the
time it stopped at
toll booth of Talmadge
Memorial Bridge,
spanning Savannah
River, Georgia.*



*Discovered loose
connection in
ignition. Remedy:
wiggling key*

*On a Lake Michigan
beach below Benton Harbor car
was tested for its transaxle
traction. It showed no
reluctance in soft sand*

*Heavy rains disclosed
two water leaks at
top of windshield*



*Only good brakes
saved the life of a
pooch that ran in
front of the car*

Tempest

*Had to drive at a
crawl for miles.
Trouble: fog. Engine
stayed cool*

*Gas attendant counted
plugs three times. "Is
the Model A back?" he
asked*

*Soft shocks produced
pounding and wallowing
on cowpath-type roads*

*Gas-pump jockey forgot
to replace oil-filler cap.
Oil splattered engine in
fast driving . . .*

*. . . Pontiac dealer said
sorry, no Tempest caps
received yet. Tried
regular V-8 cap. It fitted*



*Tempest emerges from main gate
at Orton, a pre-Revolutionary
North Carolina rice plantation.*

CONTINUED



Taking fast corner on a dirt road demonstrates behavior of independently suspended rear wheels under side stress. Rear end is willing to break loose. With Tempest, inside wheel loses traction, and outside one begins drifting. Drift is easily controlled.

THE Pontiac Tempest is the year's most unconventional new car. As a piece of machinery, it's unique. It's the first U. S. mass-produced 4-cylinder car since Ford's Model A. It's the first car with a front-mounted engine and a rear-mounted transmission in 40 years. And it's the first to have a curved, limber drive shaft.

Our test indicates that it may prove to be as controversial as it is unconventional. Some of its drivers liked it unabashedly. They found it spunky, capable, pleasant to drive. Others gave it a bilious eye: It vibrated, made noises, and was poorly sprung.

The test team, of a half dozen POPULAR SCIENCE staff members of various shades of taste and experience, agreed on some points. The car hums along like a V-8 in a wide spectrum of cruising speeds.

It's economical. It generally keeps its feet in rough going. And it has a tight, well-designed body. Here is our report:

Fuel Consumption

The Tempest's overall fuel economy in more than 10,000 miles of all kinds of driving was 20.25 miles per gallon. A stop-and-go record of 18.7 miles per gallon seemed excellent for a roomy station wagon weighing more than 3,000 pounds.

One surprising finding was that fuel mileage differed so little from that of the 155-hp. V-8 in the Olds F-85 tested last month (see box). Part of the explanation lies in axle ratios. The Tempest has a 3.55:1 axle, the F-85 a 3.08:1. The numerically higher the axle ratio, the more times the engine turns over—the more fuel it uses—for every revolution of the driving wheels.

How the Tempest compared with PS's F-85 and 1960 Corvair, Falcon, and Valiant

	Tempest	F-85	Corvair	Falcon	Valiant
Overall average miles per gallon	20.25 m.p.g.	20.21 m.p.g.	23.43 m.p.g.	26.56 m.p.g.	20.31 m.p.g.
Gas mileage at constant speeds					
30 m.p.h.	28.4 m.p.g.	27.9 m.p.g.	26.6 m.p.g.	30.2 m.p.g.	25.8 m.p.g.
40 m.p.h.	27 m.p.g.	26.8 m.p.g.	24.2 m.p.g.	29 m.p.g.	24.2 m.p.g.
50 m.p.h.	24.9 m.p.g.	24.9 m.p.g.	23.6 m.p.g.	28.1 m.p.g.	23.9 m.p.g.
60 m.p.h.	22 m.p.g.	21.6 m.p.g.	22.6 m.p.g.	27.1 m.p.g.	22 m.p.g.
Miles per gallon in stop-and-go driving . . .	18.7 m.p.g.	15.03 m.p.g.	21 m.p.g.	22.4 m.p.g.	19.6 m.p.g.
0-60 acceleration	13.5 sec.	13.8 sec.	17 sec.	22.9 sec.	17 sec.
Top speed	96-plus	100-plus	88 m.p.h.	78 m.p.h.	96 m.p.h.
Total oil consumption	1 qt.	4 qt.	4 qt.	1 qt.	3 qt.
Gas-oil cost per mile	\$.0163	\$.0162	\$.0145	\$.0122	\$.0163
Overall direct operating cost per mile	\$.0186	\$.0172	\$.0184	\$.0147	\$.0206

Despite a disparity in wheel sizes—the Tempest's 15-inch as against the F-85's 13-inch—its engine revolutions per mile in high gear number 2,807, or upward of 200 more than the F-85's. Moreover, the Tempest engine has to work harder, for the cast-iron four is substantially heavier than the aluminum V-8.

Handling

Senior Editor Martin Mann, first witness for the prosecution, was unhappy with the gearbox. "It whines," he reported, "like a pickup truck in first and second. It also whines in high when you let the engine brake you down from 50 m.p.h."

He also found the throws on the floor-mounted gearshift too long—"You put your fingers in the ash tray in shifting into second."

To Mann's objection to the use of a floor-mounted shift, Managing Editor Frank Rowsome said: "There's a yes-but, here. The floor location may have been dictated by the rear transmission—to simplify linkage."

Rowsome posed a problem for the disaff side of the family: "Heavy traffic occasionally demands a double shift into unsynchronized low while the car is moving—something few wives can be taught to do. And the accelerator must be handled gently to keep from lugging the engine at speeds below 22 in high."

Editor Howard Allaway, addressing himself to Pontiac's head man, Semon Knudsen, commented: "Next year, please, a synchronized first gear."

Detroit Editor Ken Fermoye found the steering precise and easy. Others



Tempest foots cautiously to brink of an "overlook" in Virginia's Blue Ridge mountains. Brakes were superb.



Only one of the dozen drivers and co-drivers felt impelled to stop and stretch occasionally due to discomfort of seat.

Car loiters beneath a Deep South oak festooned with moss in a rare moment of repose during the 10,000 miles of driving. Transaxle operation normally did not reach the ears, but clanks emerged from it when bottomed on deeply rutted side roads.





Bench drill press and portable power saw are loaded with plenty of room to spare. Compartment is 44 inches wide, 88 long.

agreed up to the point of hard cornering, when several drivers reported a tendency toward oversteering—a tightening of the turn that required backing off on the wheel.

Technical Editor Hubert Lockett said: "You have to press this car really hard to get any actual oversteer. Even then, it's not dangerous. In a moderately hard turn, it does move from understeer to neutral-steer. This can be momentarily alarming to drivers accustomed to conventional Detroit understeering.

"But—and this is important—at high speed, the Tempest doesn't impart that light, quivery feeling that is characteristic of oversteer cars."

The question of road adhesion also brought a mixed verdict. The three hardest drivers found that the rear end could be readily broken loose. "More easily,"

How Well Was It Designed and Built?

Like the Chevy Corvair, the Pontiac Tempest design is a bold, imaginative departure from Detroit's conventional automobiles. In sum, the car is well-built. Like all cars, it has its faults. Here are some:

- The engine and drive train vibrate at some speeds.
- The independently-sprung rear wheels tend to lose traction faster than cars with solid axles in hard turns.
- The front-wheel geometry gives slight oversteer in a hard turn.

How the Tempest's Tires Stood Up

A tire expert measured tread depth at 10,112 miles. Since the 6.50 X 15 Firestones had not been switched at 5,000 miles, four instead of five tires shared all the wear. Each front tire had lost 20 percent of its tread, each rear tire 25 percent. His estimate of projected tire life: a rather remarkable 40,000 on four tires; close to 48,000 on five that were rotated regularly.

said Associate Editor Alex Markovich, "than you'd expect on a car with 50-50 weight distribution."

Everyone liked the brakes. Lockett found none of the oversensitiveness that he had encountered in the F-85. The foot pressure required in hard stops was fairly high, but, he said, that was preferable to the grabbiness caused by excessive servo action. Rowsome added that the brakes did fine in hard mountain driving.

Allaway, capsuling the handling: "I like this car. In fast, heavy, three-lane turnpike traffic, I felt more secure—more in command—than in any other car I've driven in the last couple of years, with the possible exception of the Corvair."

The Ride

Lockett said: "The ride is smooth on good roads. The biggest problem is pitch on wavy surfaces when the wheels deflect at the same moment. The car shows up best on pocked roads, when the springs deflect independently."

To Fermoye, the ride was comfortable, though "a bit thuddy on potholes." Both Markovich and Rowsome would have liked stiffer shocks. Mann said, "The ride is excellent except at speeds around

- The gearshift throws are too long.
- The ride, in general, is hard.
- Too much road shock reaches body, steering wheel, and shift lever.
- On some roads, the body pitches.
- The one-piece tailgate forbids long loads.
- The seats lack depth.
- The windshield developed water leaks.
- The ignition switch had an intermittent contact.

Crossing into Canada for magnificent view of Niagara Falls, Tempest drivers were greeted by customs officer's query: "What make of car is that?"



50 on concrete. There the asphalt expansion strips do set up a pitch. Evidently there's a harmonic."

Performance

For Allaway, the passing power between 40 and 65 in high gear was all that anybody would want. "In slower traffic," he added, "the performance is spry if you're willing to make use of second gear, as obviously was intended."

Markovich, who strikes the rest of the staff as a frustrated racing driver, said, "High-speed passing on two-lane roads is nerve-racking—there's no guts to the engine in the upper ranges." Hastily, he added, "But once you get used to winding in and out of the lower gears, you get all the snap you want in city traffic."

From Rowsome: "This big, fat four has plenty of torque. If you wring it out, shift late and quick, and keep the accelerator on the floor, you can go real briskly. Even in standard trim, the Tempest will 'way out-perform the Falcon and Corvair."

"Hills and passing are little problem, though the high-speed pass—say, 65 and above— isn't as vigorous as in a big-engined car. I think the top speed—96 m.p.h. indicated—might be bettered some

with a numerically lower rear axle."

The Tempest had ample power for Mann on hills, but the engine lugged badly after a slow corner. Lockett's reaction was a contrast: "Sure, it lugs. It's a four-cylinder engine, after all. But it's beautifully balanced. It spans off one-two-three-four (or one-three-four-two if you're going to get persnickety about the firing order) without a whimper even down to 10 miles an hour in high gear."

Design and Construction

Here the roof falls in on the Tempest's engineers and designers.

Rowsome: "The gearbox and clutch are noisy. You travel with throbs, grinds, pulses, bongs, and chirps. The box is very noisy on the over-run in low and second, and sometimes in high."

Lockett: "An extra source of vibration in this car was the differential, hung on the structure instead of being isolated from it as in a conventional car. The chirp that Rowsome mentions came from the clutch-release bearing—but this is a normal, easy fix under the warranty. The generator whined noticeably, especially in cold-weather starts."

Markovich would have liked a bigger

[Continued on page 216]



Pacing freighter on Welland Canal, Tempest easily threaded in and out of traffic on two-lane roads of Ontario.



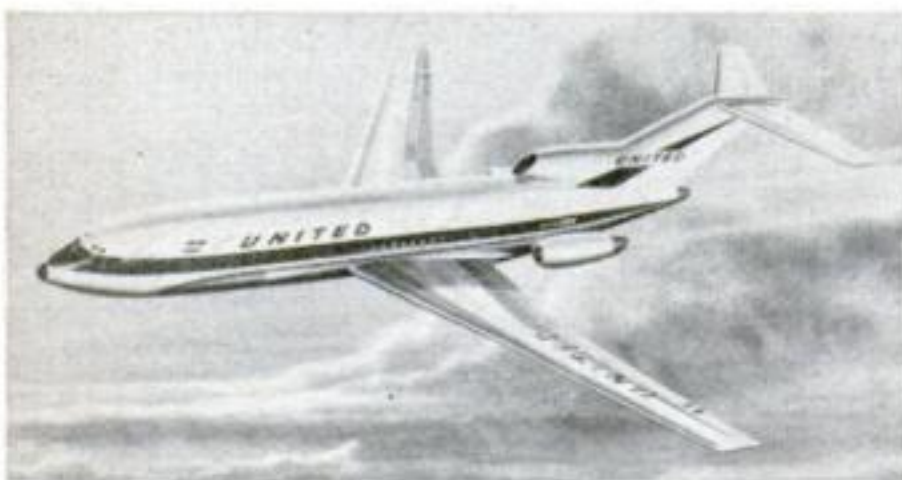
Miami: Four-banger engine developed plenty of torque in second gear for many miles of city driving like this.



Fire fighters learn smoke-eating art

Austria's volunteer firemen who attend a special school conducted for them in Vienna learn in a classroom session above the art of combating blazes. Using a

model of a typical small town, an instructor explains to them how to fight fires in the different kinds of buildings represented and under varying conditions.



Boeing 727 for short and medium hops.



Vickers Super VC-10 for flying the Atlantic.

Jet power for new airliners goes to rear

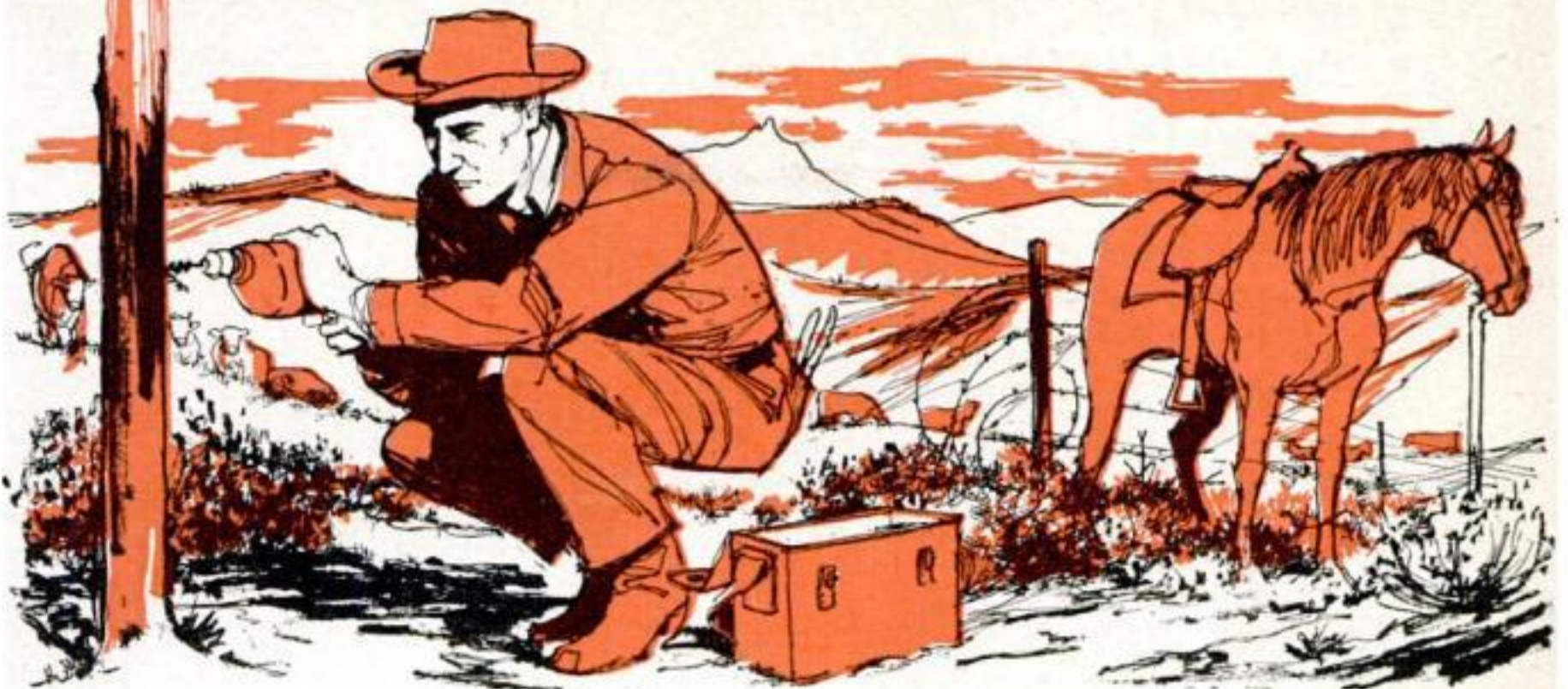
Next jet airliners will have engines in their tails. This gives more lifting power on shorter runways and makes the ride quieter for passengers. Both Boeing and British Aircraft Corp. follow the lead that France's Caravelle took several years ago, but they'll put jets smack in the tail, not just toward the rear.

Boeing will build 80 of its new 727s for two airlines: Eastern and United. It uses three jets—reminiscent of the old Ford tri-motor airliners of the 1920s. It

has jets in the tail instead of props at the front. Two jets will be fastened to the sides of the tail, one on top. Of short and medium range, the plane will carry up to 114 passengers at 600 m.p.h. It will appear in 1963.

British Overseas has ordered 35 Vickers VC-10s for 1963 delivery and 10 Super VC-10s for 1965. The Super 10 is a stretched version of the standard, will carry up to 187 passengers, or 212 in economy class, in transatlantic flight.

"I'd like to see them make..."



BATTERY-OPERATED DRILLS for jobs far from a power source. You'd beef up its rechargeable

battery at an outlet before heading for the work site.—*B. W. Pierce, Norwalk, Ohio.*



A POOCH-DRYING "TENT" to replace the hood on the warm-air blowers women use on their hair. It would dry a dog after a bath or a walk in the rain.—*W. Ronson, Jamaica, N.Y.*



A MAGNETIC BELT to hold nails and small parts for a man doing odd jobs around the house. For women, one to hold straight pins or bobby pins.—*Muriel Carey, New Castle, Pa.*



COOL-TO-THE-TOUCH electric irons with all outer parts except the sole plate cast in one piece of an asbestos-cement and fiber-glass composition.—*S. L. Steigman, Howard Beach, N.Y.*



FOR BETTER TRACTION, metal tanks under the beds of pickup trucks. You'd fill them with water. A drain plug would allow emptying when desired.—*W. F. May, Crestwood, Ky.*

Everyone has his own pet idea of a gadget that he would like to see in general use. The five ideas illustrated above were suggested by POPULAR SCIENCE readers. What's

yours? We will pay \$5 for each one published. Please use Government postcards only. Write name and address clearly. Contributions cannot be acknowledged or returned.

The Show Goes On ...15 Feet Under Water



By Gordon P. Manning

A THIRD of the way down the Florida peninsula, on the Gulf side, the world's most unusual theater has just been opened. Seating 400 spectators, it's 15 feet under water.

They're as dry as toast. But the actors aren't. They swim about in a spring-fed lake. Separating actors and spectators are 19 giant picture windows, each 2½ inches thick.

That's only part of the weird goings-on. The actors come "onstage" seemingly from the bottom of the lake, and depart the same way.

All this took some doing. Like the hull of a ship, the big auditorium wants to float. It had to be anchored down. A way had to be found to get the performers—mermaids—down to a water depth that would pop them in front of the picture windows from below.

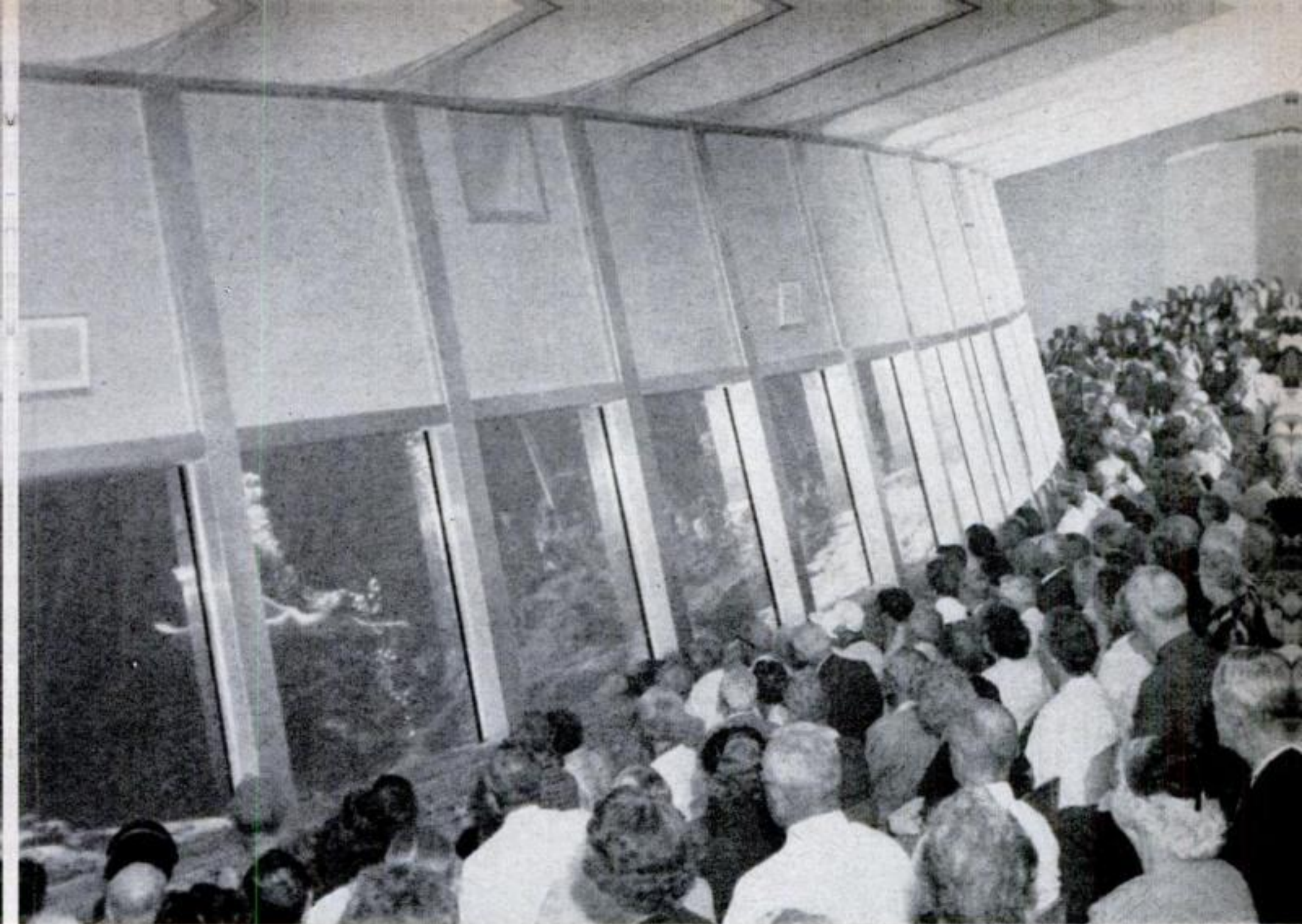
How engineers solved the problems of their underwater theater at Florida's Weeki Wachee Springs is shown in the accompanying photographs.

Mermaid makes eyes at you through a glass window in submerged playhouse. Fish-tail model wiggles in time to lilting underwater music.

How they built the world's

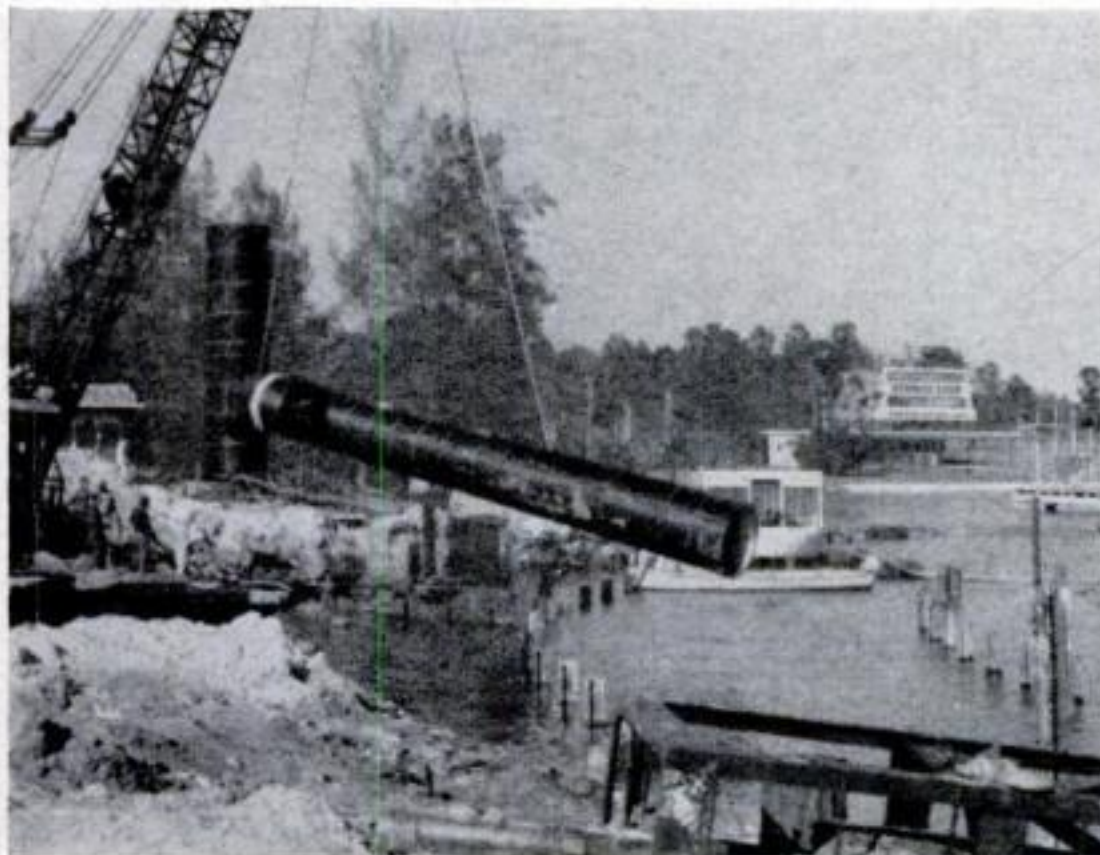


1 Underwater theater rests on top of 51 steel piles sunk down 125 feet. Here H-beams are being power-driven into place.



Necks are craned as a seated audience of 400 people watches the underwater spectacle at Weeki Wachee in Florida. The air-conditioned luxury auditorium gives viewers an intimate peek into the deep.

first submarine theater

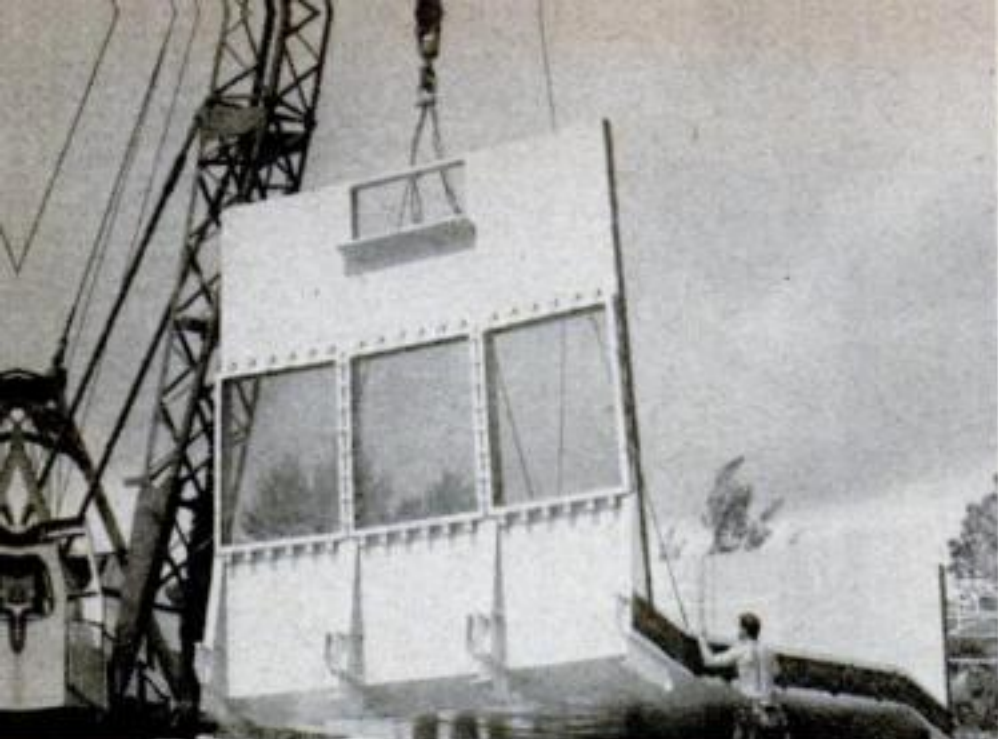


2 *Entrance tunnel for the performing mermaids, a 60-foot-long pipe, is lowered into place before the main prefab sections are set.*



3 *Prefabricated steel sections of the auditorium, each weighing more than 17 tons, were trailer-hauled to the installation site.*

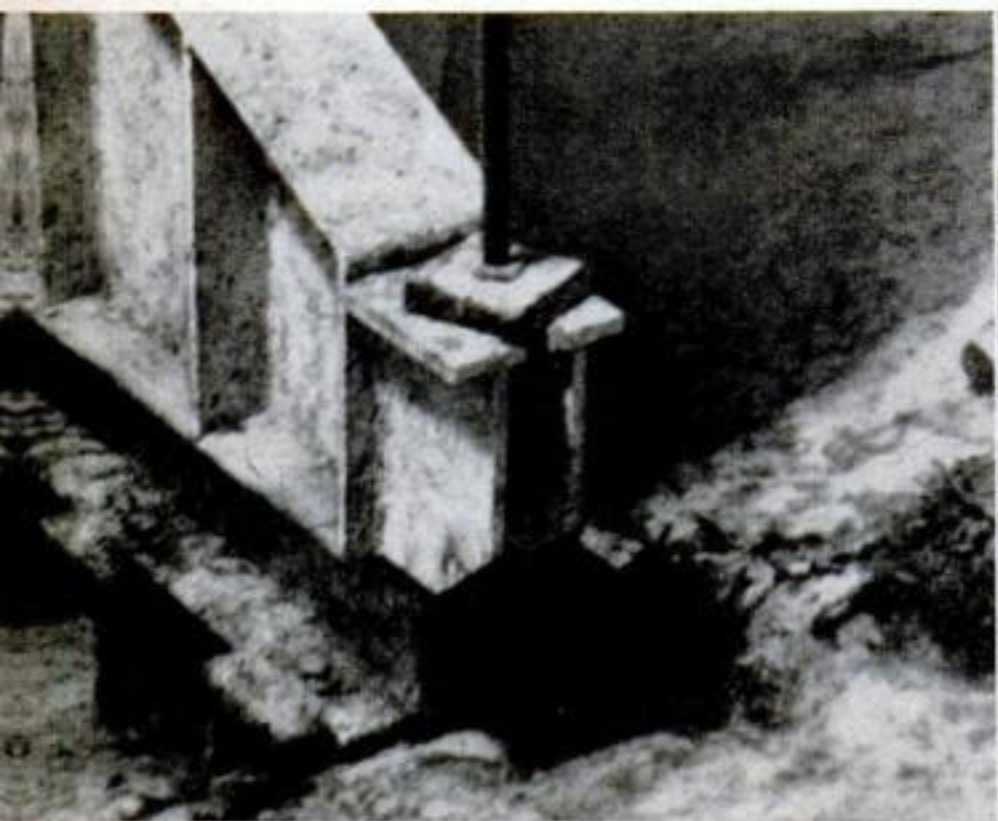
CONTINUED



4 Big windows are made of shatterproof glass. Tilted to avoid reflection, they are set in panels 15 feet wide, 17 feet high.



5 Divers were used to bolt and then weld 5/16" steel sections together as in a ship's hull. Neoprene gaskets make temporary joints.



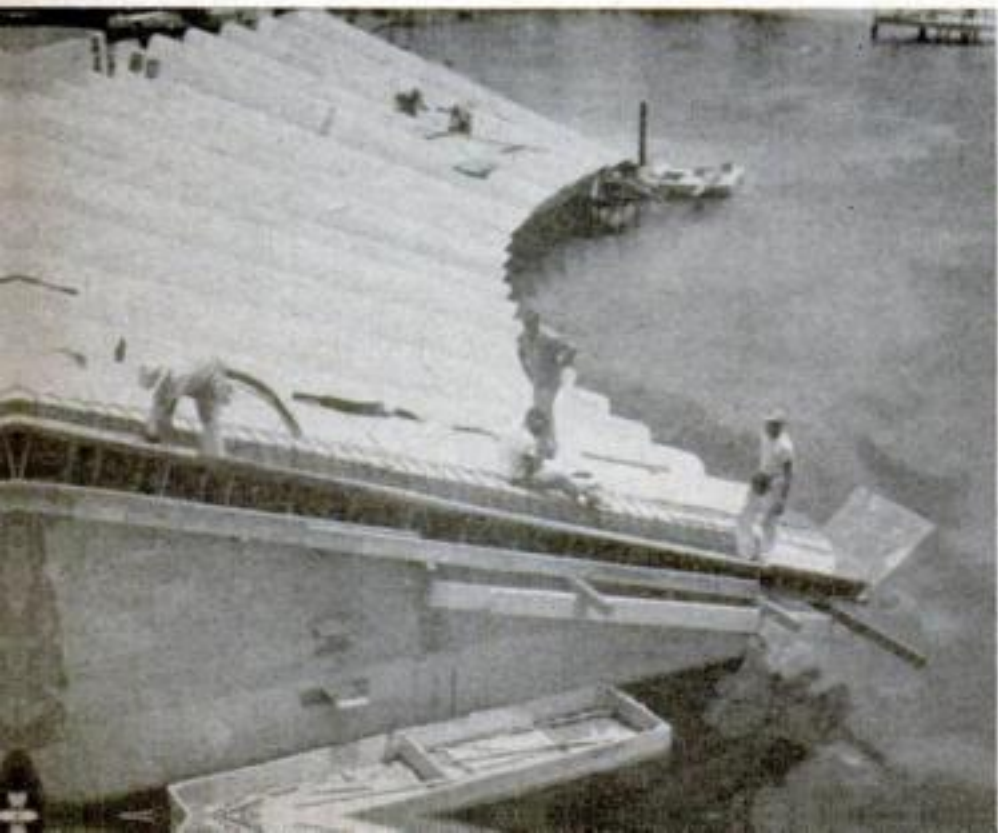
8 Hardened steel rods—there are 51 of them—hold the submarine auditorium down tightly. They go 40 feet down, are anchored in concrete.

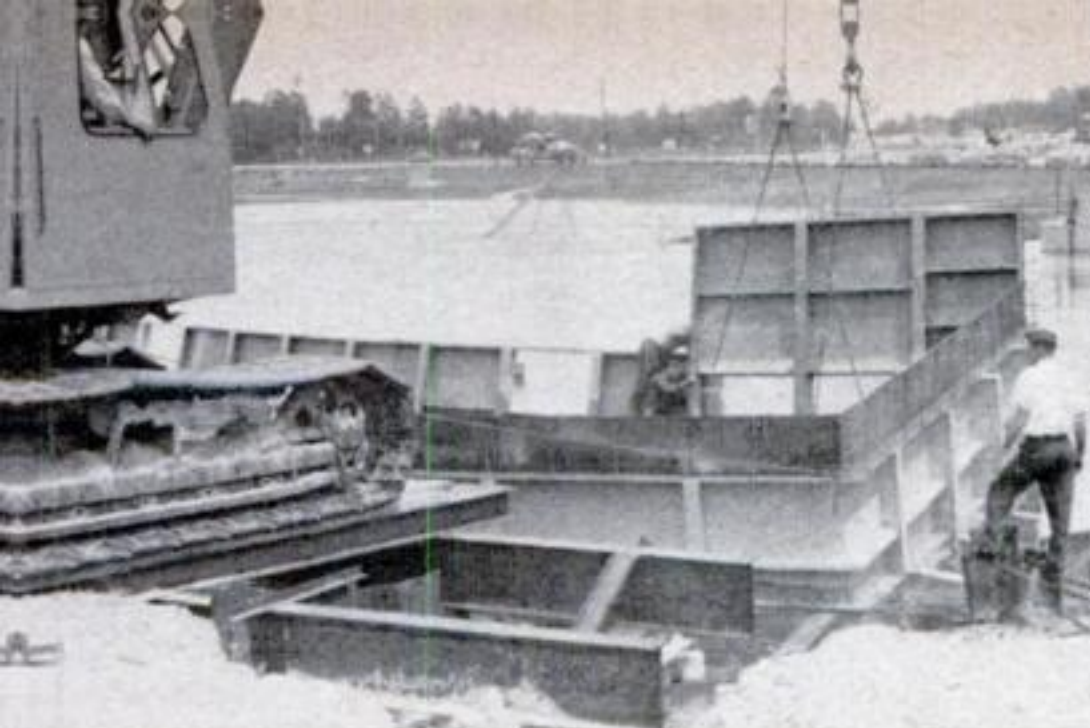
11 One year from start, last edge of the roof is being readied for concrete-pouring. The theater's top alone weighs 125 tons.



9 Pumped out for the first time, the giant undersea balcony stays put—and dry. Contractors had their fingers crossed as the test was made.

12 Scaffolds were brought in for roof plastering. Here you can see slant of window glass that gives the audience a nonglare view of the water show.

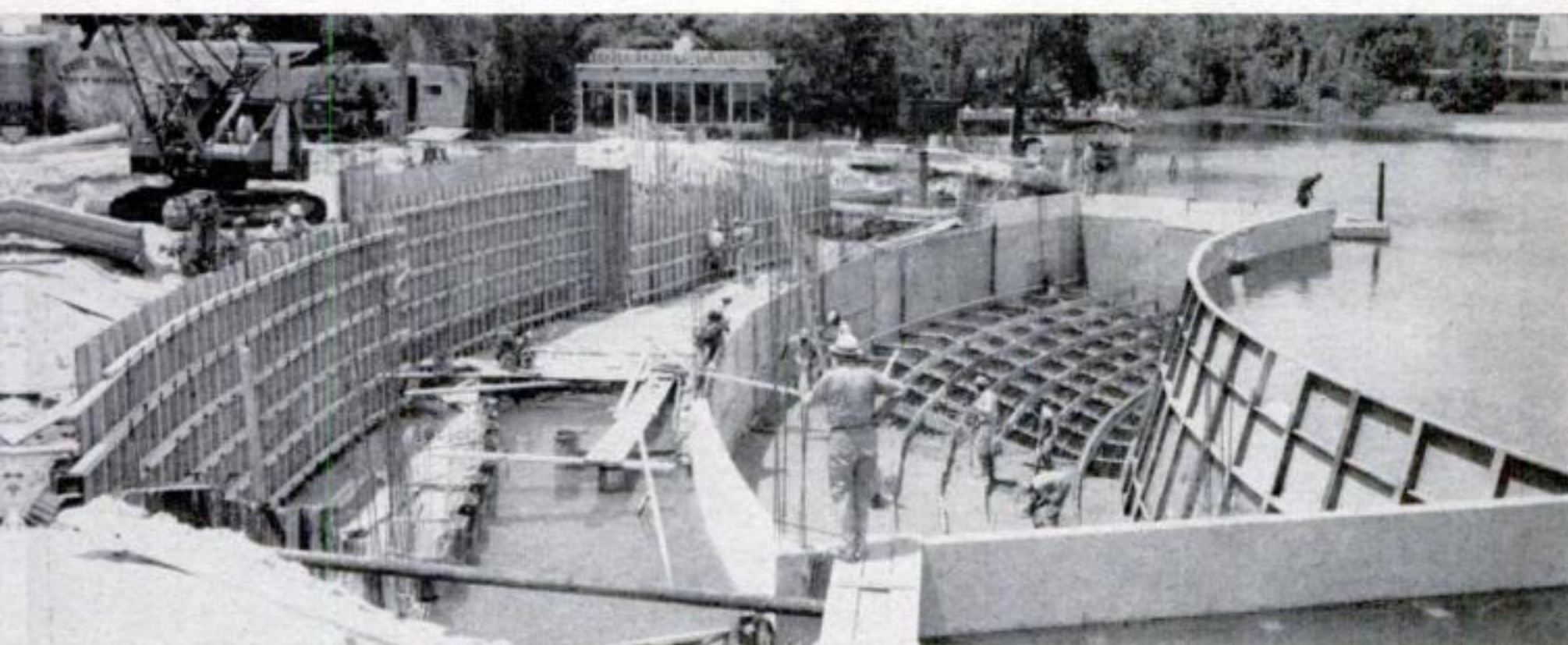




6 Final section of the 125-foot theater hull is dropped into place. A track-mounted crane was used to handle the big steel panels.



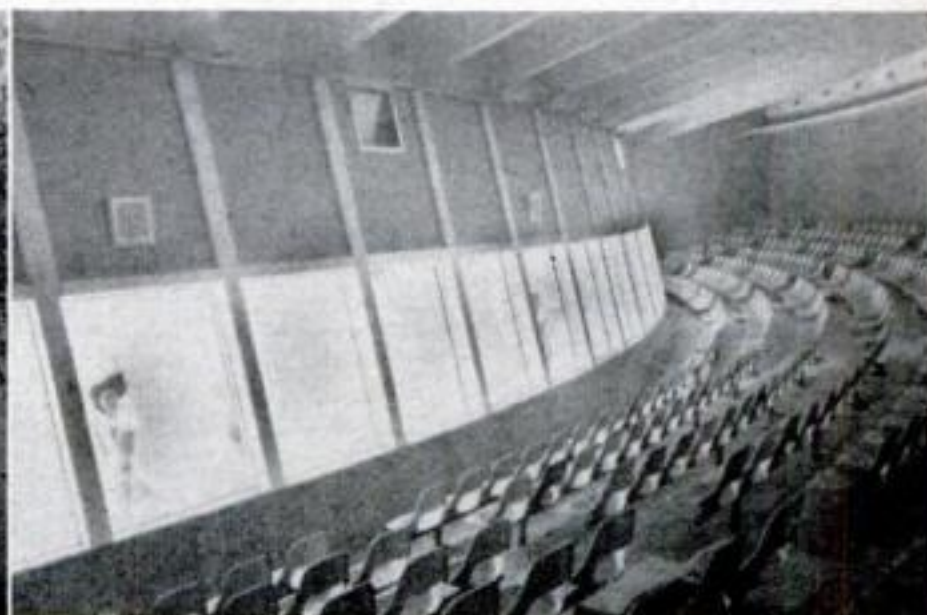
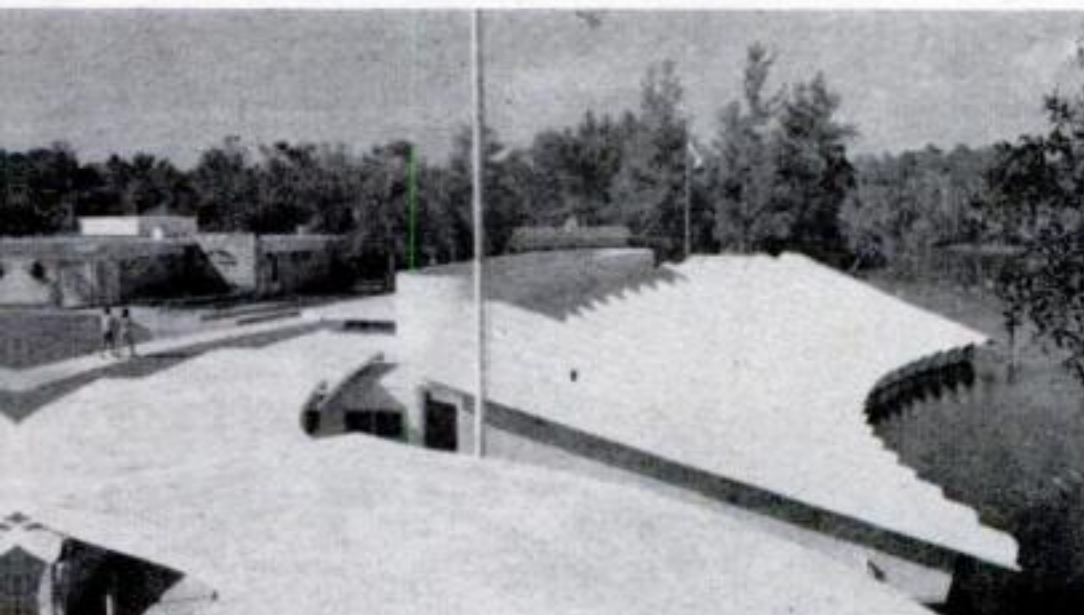
7 Divers take a breather between underwater welding chores. Top of steel hull comes above surface so that theater can be pumped dry.



10 Concrete work is being finished—400 tons of it just for the theater floors. Workmen at left in the photograph are preparing forms for pouring the lobby and entrance ramps.

13 Florida's underwater theater is finished—700 tons of submersible steel—an anchored bathtub that holds an audience snug and dry.

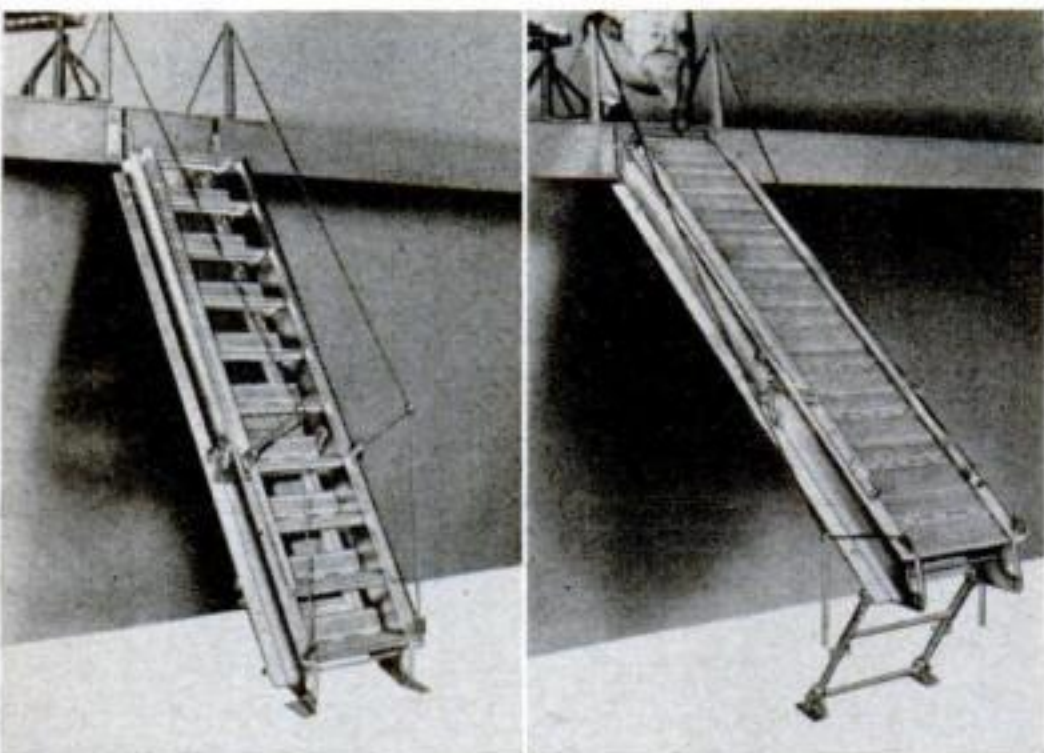
14 Fifteen feet under water, this novel theater features a show of merry mermaids mingling with nature's denizens of the deep.





9,000 antennas

This huge radar contains nearly 9,000 antennas under its slanted screen. They enable the ESAR (short for Electronically Steerable Array Radar) to sight a wide expanse of space and to track hundreds of targets at the same time without turning its head. The radar was built by Bendix for the Air Force and Advanced Research Projects Agency. It is in operation at Towson, Md.



In ladder position.

In chute position.

Stairway has dual purpose

An aluminum ship ladder that will also slide supplies from deck to deck is being tested by the Navy. With a flick of a lever, it is transformed from steps for personnel to a chute.



Pistol-packin' mama

The fastest electric gun in the East, this Boston plant worker uses a holster to hold her solderless wire connector while she wraps wires onto terminals in an electronic computer for Minneapolis-Honeywell. With 1.4 million wire connections, the computer makes up to 40,000 calculations per second.



Ping-pong eyes

With her eyes cupped by halves of ping-pong balls, this University of Michigan graduate student can't see a thing—except color and brightness. Using this device, university researchers have established that, although they can't distinguish lines or shape, eyes are still sensitive to changes—like looking into a dense fog, heavy snow, or sky from a high-flying plane.

**There's more phony green
on the scene than ever,
so be wary—or be sorry**



Counterfeiting: A Tough Way to Make Money

By Joan Steen

MAKING money—in private competition with the U.S. Treasury—is all but impossible. Yet the number of ink-stained souls caught printing or passing bogus bills every year is surprisingly high. And getting higher. There were 412 arrests on counterfeiting charges in 1960—20 percent more than in 1959. New issues of counterfeit notes—ones not matching any on record—were up 26 percent in the same period. And phony money estimated to be in circulation has more than doubled in the last five years—from \$107,000 in 1955 to over a quarter of a million dollars now.

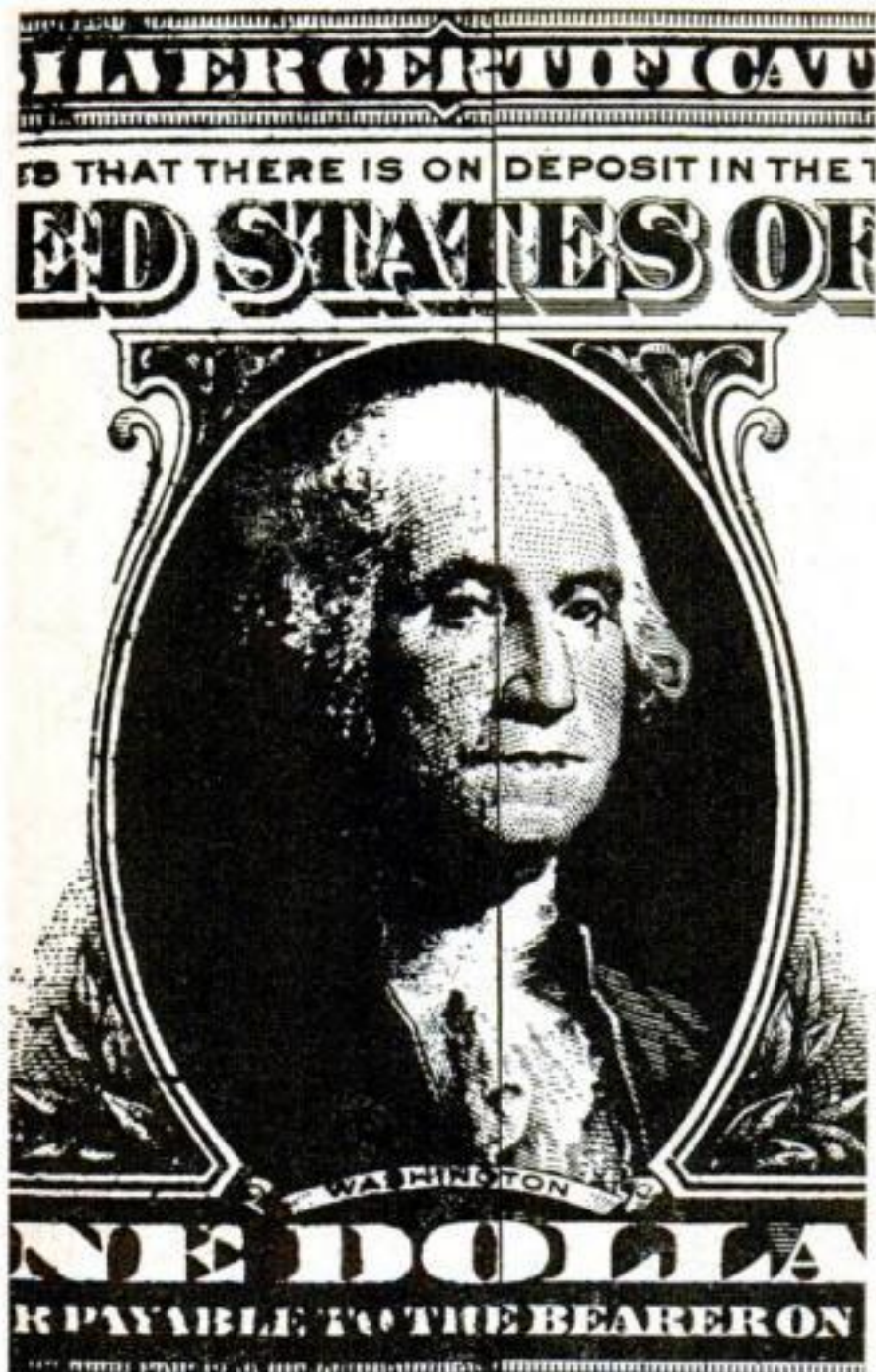
You may have passed a fake bill without knowing it. If you had looked twice, however, you might have spotted it. For

while the latest crop of false money-makers are using slicker methods, their products are almost sure to be only feeble facsimiles of the real thing. The reason: too many government-planned obstacles to overcome.

- The paper the Treasury Department uses is a blend of cotton and linen fibers made especially strong, durable, and flexible. Scattered through it are telltale red and blue fibers, a distinctive earmark counterfeiters often don't even try to cope with.

- The same goes for the ink. Its formula is secret and its production controlled—inside the Bureau of Engraving and Printing itself. There huge batch mixers blend pigments, binders, and extenders to make ink that's as quick-drying, nonfading, and permanent as possible.

Counterfeiting is big business—professionals aren't after



HOW THEY COMPARE: Bad bill on the left is easy to spot when paired with a bona fide specimen. Note the smudged, flat effect; too-heavy use of ink; unclear border details.

This is counterfeit



PHONY'S INFERIORITY is revealed in this close-up. Under magnification the bad plates show irregular and broken lines. The printed results are dull and scratchy. The portrait tends to merge with the background.



• But the plates themselves are the real stopper. Not only does the Bureau hire some of the country's best engravers, but it also insists that each work only on a particular specialty—portraits, lettering, or scrollwork. No one man engraves a whole plate. To cut the complex border design on bills, elaborate geometric lathes are used. The diamond points make faultless, even-pressure cuts.

Yet counterfeiters grow and multiply. Are they, despite all precautions, getting better? Is money easier to make?

So it seems. Counterfeiters are a strange breed, challenged almost beyond belief by the task of making money of their own. And now there are new techniques to help them.

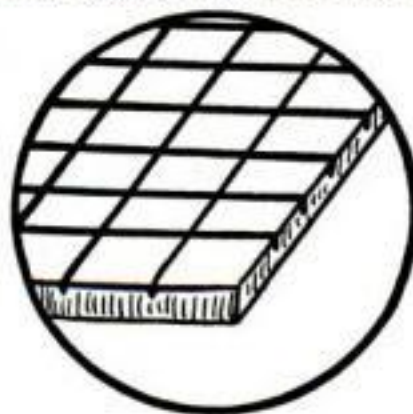
Sharper cameras. Bureau analysts point to today's top-notch cameras. They say that about 90 percent of the off-green stuff in circulation has been printed from photoengraved plates that are getting impressively more detailed. Sure, the off-set-printing results are duller and flatter than the Bureau's own "three-dimensional" intaglio process (where the paper is forced at 100-ton pressure onto ink-filled grooves of the press plates). But the phonies are good enough to pass.

That's the trouble. Counterfeiters count on carelessness. They figure the average citizen won't notice Hamilton's

This is real



EXPERT ENGRAVING in genuine bill makes portrait stand out from the oval background. The eyes appear lifelike. The fine etched lines show up even in the dark areas. The background screen of crossed lines is uniform.



the change from a fake ten-spot

smudged neck, or the buck-tooth gaps in the edge of the Treasury seal. He might even accept a bill with the wrong portrait on it. (Do you know whose picture is on a \$20 bill?)

But sooner or later the fake turns up in the offices of the Secret Service in Washington. There it is put through an analytic mill, photographed, and a fact card describing it sent to all banks. That's automatic. Then comes the tough step—tracking down the gang.

Secret Service agents may get a break in tracing the paper used. That happened in the Riadon-Byars-Fulcher case.

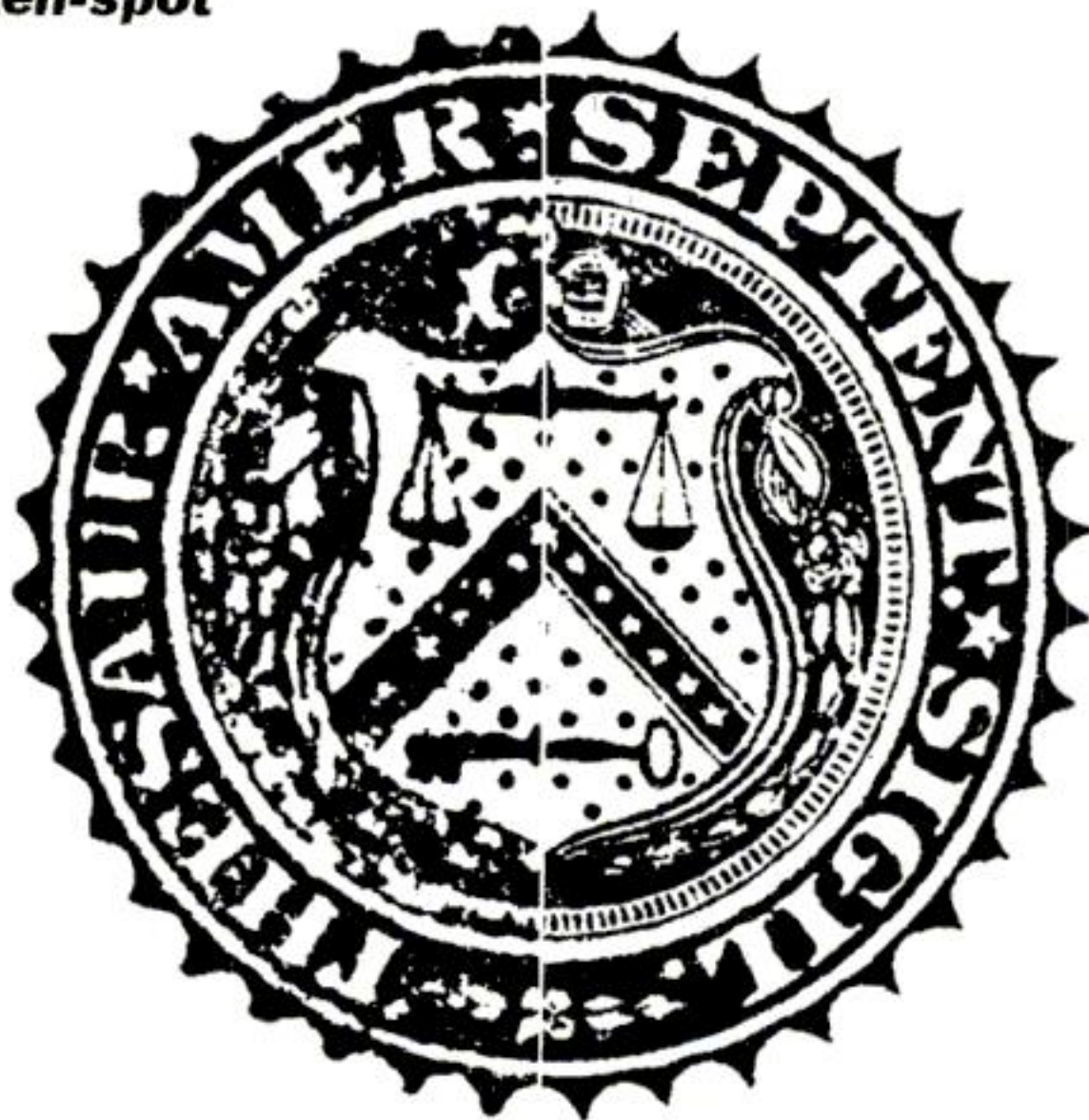
Late in 1957 a flurry of phony tens and twenties (the most popular counterfeit denominations) showed

up in Chicago and Indianapolis. Chicago agents found a watermark on one of the bills, traced the paper manufacturer, and started checking purchasers. The tedious business paid off when the agents learned of two men from Memphis who had bought paper, printing machinery, and a large camera.

Meanwhile note passers were being picked up in Nashville, Atlanta, and as far south as Bartow, Fla. Then a tip-off came of a distributor in Memphis—John Riadon. An undercover agent, posing as a criminal interested in buying large quantities of notes, arranged to fly with Riadon to Nashville where, he assured Riadon, another good customer would be waiting.

The second customer was, of course, another agent. He arrested Riadon in the act of turning over \$72,000 at the airport. John Byars, long-time bootlegger and financial backer of the gang, was then picked up. He was one of the Chicago paper buyers. The press was found in the Tennessee backwoods farmhouse of the third gang member, Richard Fulcher, the other paper buyer.

T-Men circulate, too. Solving a case



CREASE A SUSPECTED BILL through the Treasury seal and match it with a real bill for a quick check. Here the phony ten on the left shows irregular and broken saw-tooth points.

like that is like working to the center of a spider web from a flimsy end strand. Between the local hoodlum who tries to pass the first bill, and the organized gang at the center, lie months of tangled investigation that may fan out across the country. Any of the 300 Secret Service agents may be called on to pose as criminals, to work their way through an underworld of "middlemen" until they reach the counterfeiting source, where the big money lies.

For much counterfeiting is big business. The professionals who back it aren't out to peddle for the change they get from a phony ten, but to sell notes wholesale—in lots of 50,000 or 100,000 dollars.

So counterfeit money may stay in circulation long after the press has been seized and the counterfeiters jailed. In the Riadon case, 51 arrests were made, and \$153,000 seized—two-thirds of this before it had a chance to circulate. But some of that money is still around.

Pushing the C-notes. Thirty-five arrests is the score so far in another big case still on the books. This time the counterfeits were \$100 notes discreetly offered for sale in criminal circles.

An undercover agent picked up the source early in the game, but not before large quantities of notes had changed hands. In the next few months they turned up from coast to coast and even in parts of Canada. Hundred-dollar bills are not as hard to circulate as you might think. Stores often accept them rather than offend a customer by close checking.

So it was that two well-dressed women were picked up in one of Houston's fashionable department stores. Professional modeling experience had worked in their favor until the Secret Service sounded the alert.

Secret Service men roamed the country. One posed as a representative of a foreign crime syndicate and picked up \$300,000 from a Chicago distributor. Other agents netted hoodlums in Miami, an ex-prize fighter in Washington, D. C., and, in one nice haul, a St. Louis gang that had bought \$5,000 worth from a convicted burglar, "Willie the Hipster" Harris.

Little guys, too. While such major moneymakers are the prime targets for the Secret Service, they're kept busy by a host of small-timers too.

Some print notes as crude as the smeared and toothless George Washingtons fed to an unsuspecting public a few years ago by a mild-mannered old man known as "Mr. 880."

Others, not equipped to print their own, try their hands at bill-splitting—slicing the two faces of a bill apart. With paper .004 inch thick, this is a delicate dissecting job. The trick is to paste the split halves of, say, a \$20 bill to the split halves of a one. The result is \$40 worth of illegal tender for the price of \$21. Risky? You'd think so.

Another trick is to bleach out part of a bill and then mark it up. One freak

on file in Washington is a Jefferson \$2 bill phoned up to \$500.

And occasionally a fake comes along that's so handsomely done it sends disquieting twinges down the spines of specialists. Then it can be compared to some of the masterful specimens turned out at the end of the last century. In that heyday of American counterfeiting, more than one gifted craftsman felt inspired to outdo the government.

Such a man was Emanuel Ninger, a New Jersey farmer. No engraver, Ninger hand-copied bills. He bought the best bond

paper, soaked it in weak coffee (to give the lucre a properly filthy look), and, while it was moist, made a faint pencil tracing of a real bill. Then, with the pride of a medieval scribe, he inked it in. The results were works of art—prized now as collector's items worth more than the fake face value.

But even he couldn't compare with Arthur Taylor and Baldwin S. Breddell—the brashest pair of counterfeiters the world has ever seen. Early experts in the art of photoengraving, T & B once produced hundred-dollar silver certificates so convincing that the

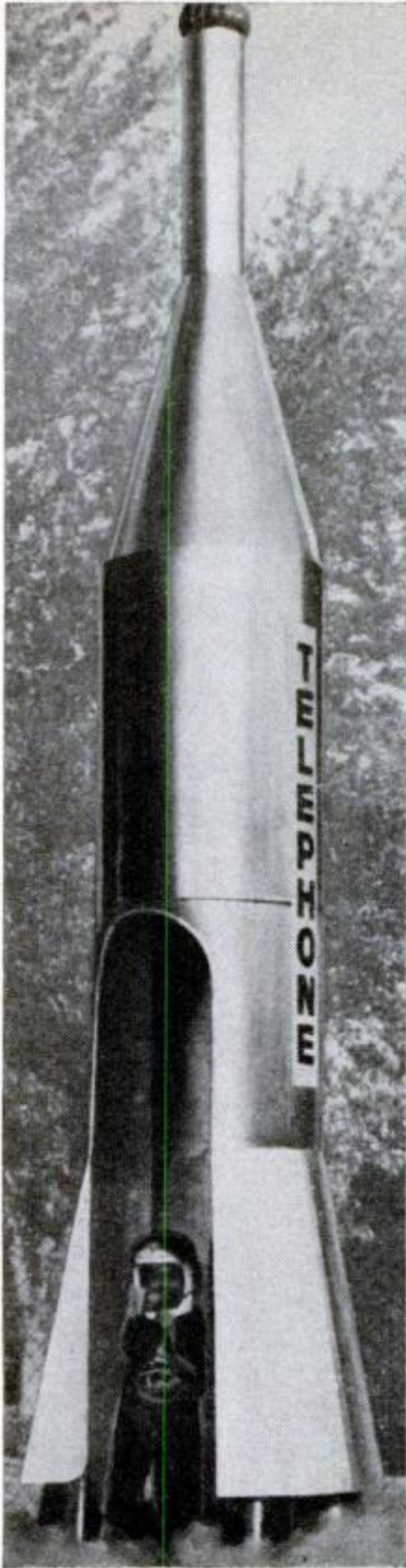
Treasury Department was forced to call in every such note in circulation and destroy its own plates.

But genius like that is rare. Today the threat comes from machines. To combat it, the Bureau of Engraving and Printing's Research and Development Department works full time. Schemes to frustrate the most skilled photoengraving equipment are evaluated. But when the researchers are not evaluating such schemes, they produce a constant flow of minute but important changes in the present currency which—understandably enough—they don't tell anyone about.



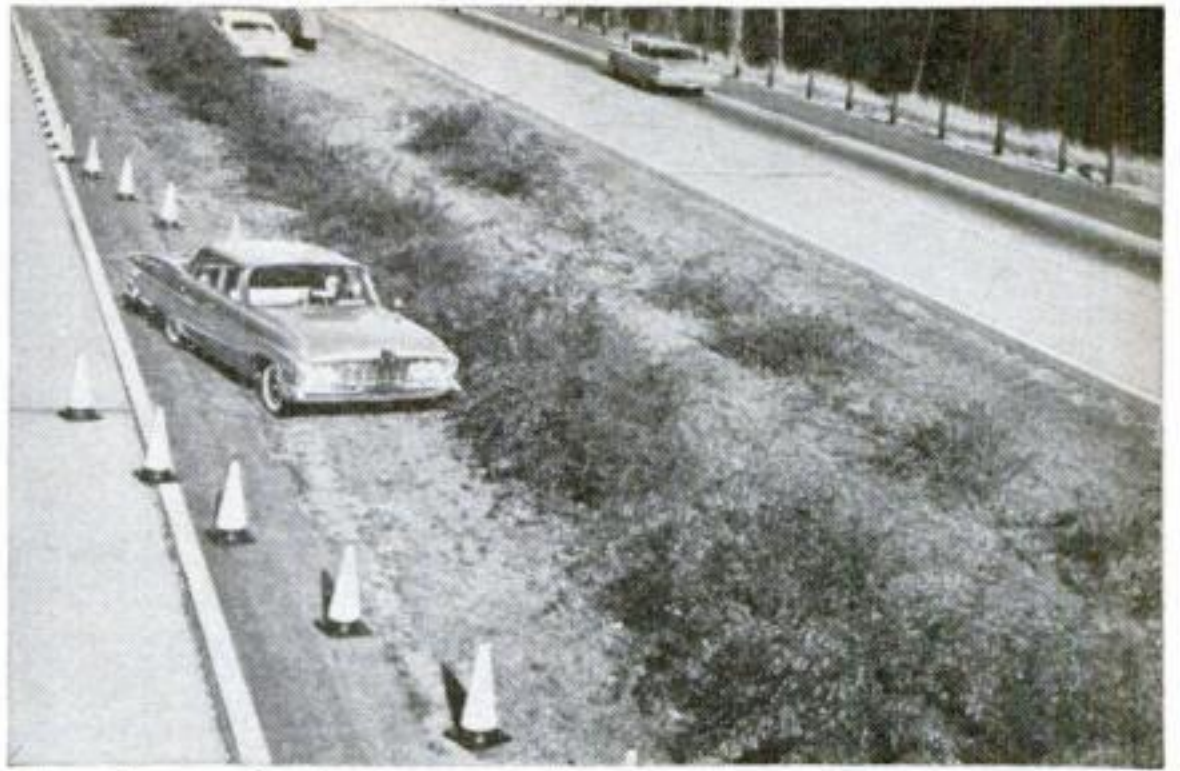
Who's on What? Can You Match the Man with the Money?

Answers: Washington appears on \$1 bills, Jefferson on \$2, Lincoln on \$5, Hamilton on \$10, Jackson on \$20, Grant on \$50, Franklin on \$100.



Space-age phone

This phone booth looks like a rocket ready to blast off into space from its launching pad. The 18-foot structure was modeled by telephone-company engineers after an actual rocket and installed in a Modesto, Calif., children's park.



Into the rosebushes . . .



. . . plowing its way through . . .



. . . out at the other side—but slowly.

Crashing among the roses

To test the value of fast-growing multiflora hedges as road dividers, the Connecticut state police sent a Dodge Dart hurtling through a row of four-year-old bushes on Wilbur Cross Parkway. The results are shown above. At 30 m.p.h. and a 15-degree angle, the car was slowed to 15 m.p.h.; at 35 m.p.h. and 10 degrees, to 10 m.p.h.; at 30 m.p.h. and five degrees, it was cut down to five m.p.h.

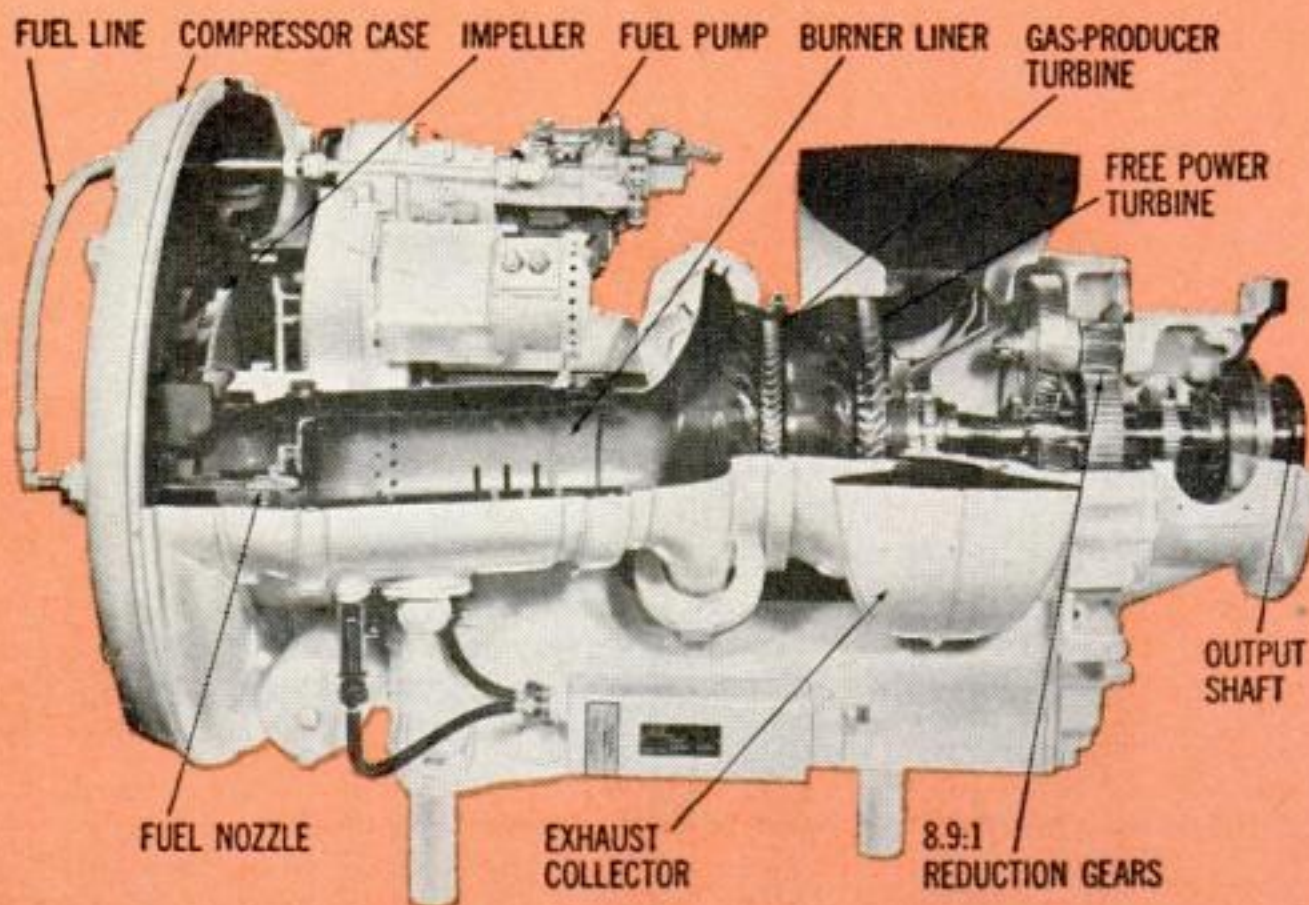
Highway authorities think a double row of more mature roses would be just about perfect. They cost less than a dollar a foot to plant compared to from \$4 to \$5 for steel rails or reinforced concrete.



STEEP HILLS ARE COMMON in San Francisco, but the Fire Department's new turbine pumper,

screaming like a banshee, climbs them faster than any conventional fire engine in the city.

First Turbine Fire Engine



GAS TURBINE operates in a simple continuous-combustion cycle. The impeller pulls in air and compresses it. The air is mixed with fuel and the charge ignited by a glow plug to power the gas-producer turbine and maintain the compression-combustion cycle. On the Boeing 502 there is no mechanical connection between the gas-producer turbine and the free power turbine. Hot exhaust gases turn the free power turbine, which is connected through reduction gearing to the output shaft.

San Francisco's new pumper with pint-size engine outpumps, outclimbs, outruns all rivals

By Wesley S. Griswold

PHOTOS BY CHESTER BORN

THE smoke-eaters of San Francisco are busting with excitement over a whining, howling new pumper they've recently acquired.

"It's a real bomb," exclaims Fire Chief William F. Murray with a wide grin. "It can pump 2,000 gallons a minute at 150 pounds' pressure. And more than half that volume of water at 300 pounds' pressure. That's terrific."

When this scarlet-and-chrome beauty recently whooshed past astonished street crowds in the singularly hilly city beside the Golden Gate, it was the only turbine-powered fire engine in the world.

By now, there should be two of them. Seattle, another city of demanding hills, is scheduled to take delivery of the second one as this magazine goes to press.

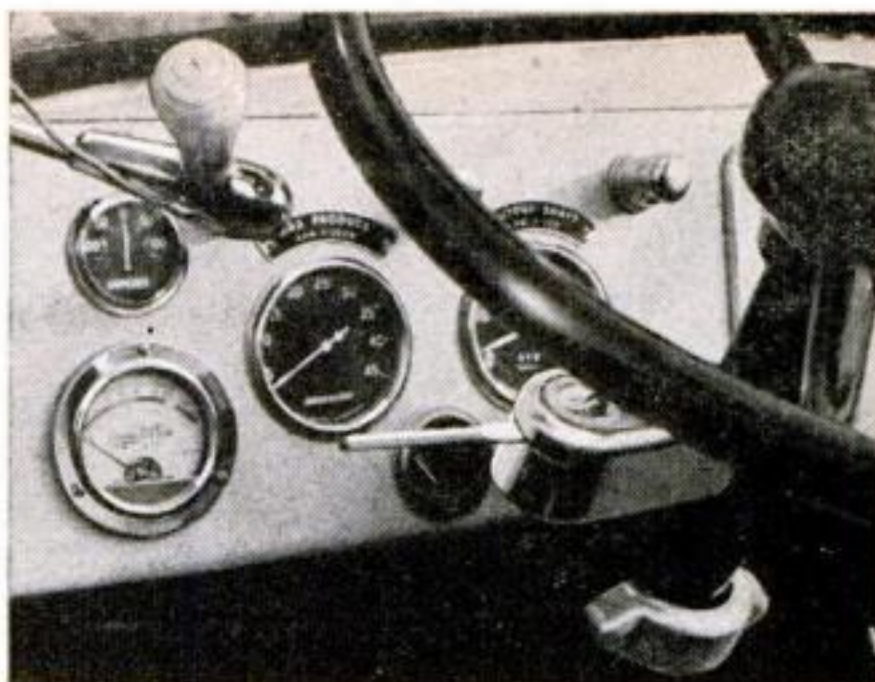
The two revolutionary fire-fighting vehicles have identical engines. Their only difference is in body style. San Francisco's pride is a 26,000-lb. pumper. Seattle's joy is a 31,500-lb., 100-foot aerial-ladder truck.

American La France, venerable builder of fire trucks, produced both of these heart-stirring newcomers. Less expectedly, their engines were made by the Boeing Airplane Co.

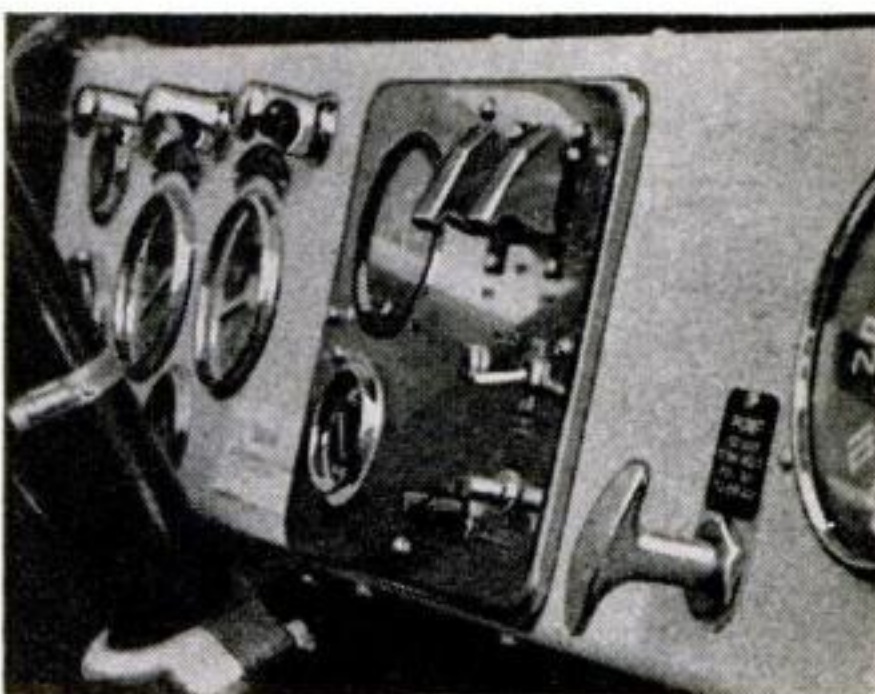
In motion, the trucks sound like a barely muffled jet plane on the loose. Yet, for all the ruckus, they make less commotion than a standard pumper on the way to a fire. The noise is just different—the roar of a forced burner mingled with a bray like that of a gale blowing through a hundred keyholes.

There is a gale in each truck's innards. At full power, air screams through the turbine engine and out the exhaust at the rate of four pounds per second.

The profile test. There's only one visual feature that quickly distinguishes the two turbine-powered fire engines from all others. That's a fat, low, rakishly angled exhaust stack, glistening with chrome plate and looking like the funnel of a small yacht. It juts up behind the driver's seat, gleaming like a subdued searchlight.



TWO NEW DIALS ON THE DASH are the large ones with dark faces and white figures. One (left) records the revolutions of the gas-producer turbine, the other those of the output shaft.

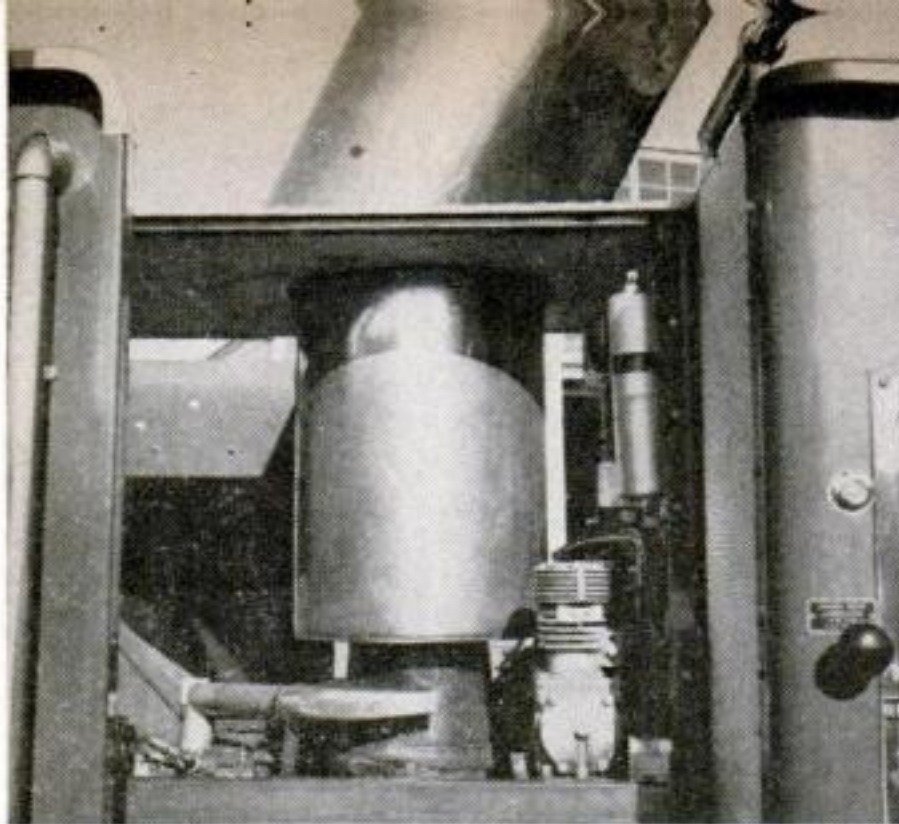


BESIDE THE STEERING POST is the starter panel. The hooded switches at top are for manual starting in case the automatic system fails. On the panel there's also an exhaust-gas temperature gauge. If this indicates too high, it's a sign of trouble inside the engine.

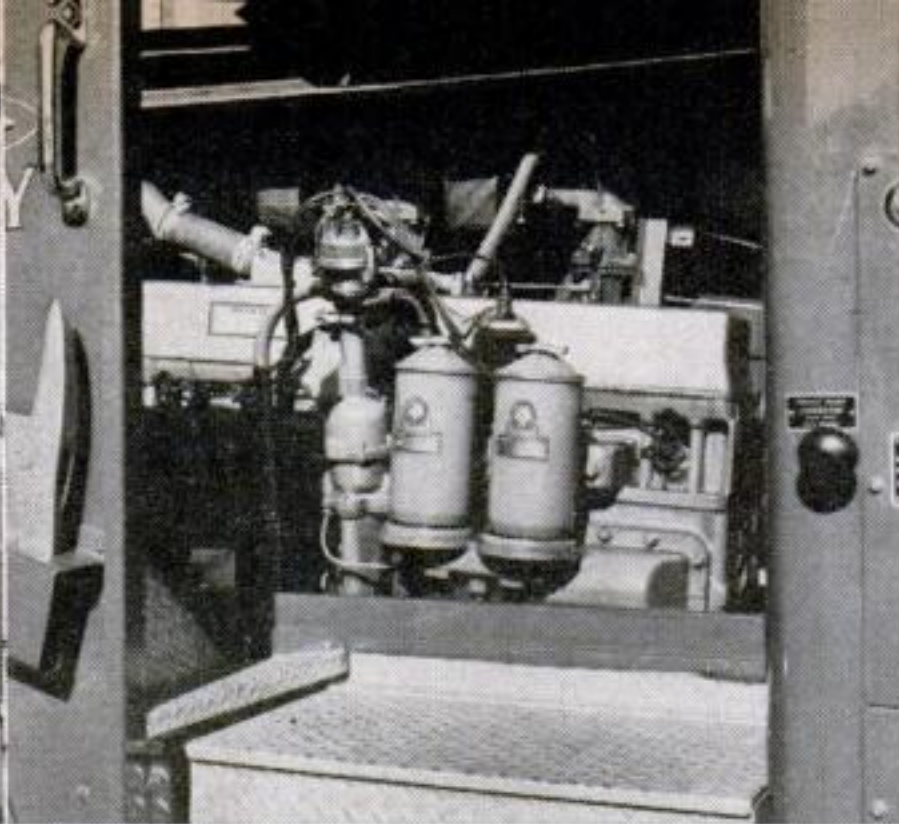


ONE BRAND-NEW DIAL (arrow) on the otherwise standard instrument panel on the port side records output-shaft revolutions. Crew of the turbine-powered pumper must watch the revs to know what volume to expect from the pump.

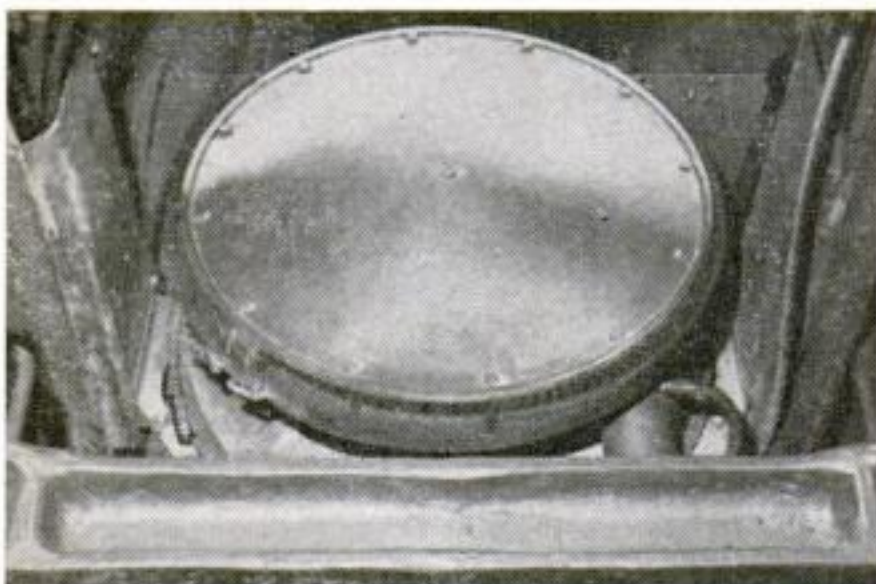
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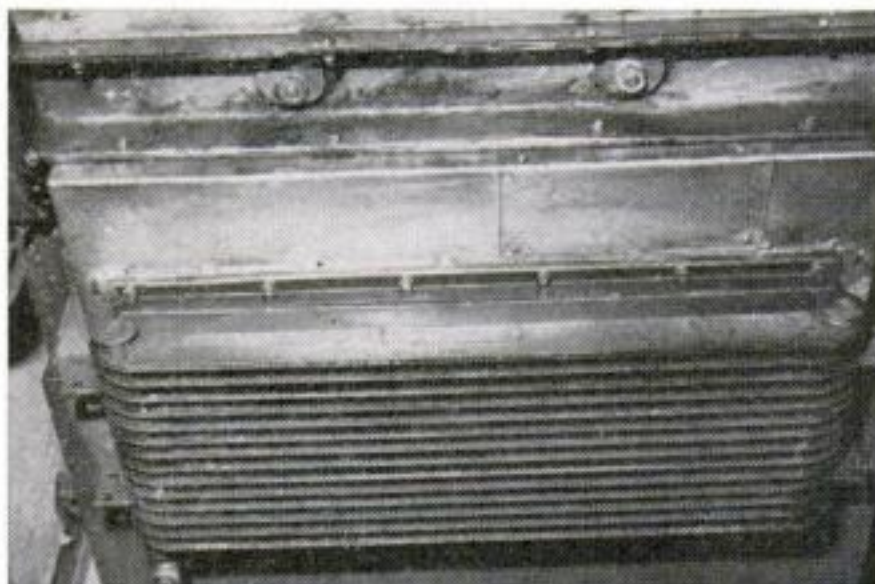
STRIKING DIFFERENCE IN SIZE between the 330-hp. turbine engine (left) and the six-cylinder, 330-hp. piston engine of a conventional pumper is shown in these comparative photos. The en-



gine compartments of the two vehicles are identical. Back of the turbine's exhaust is the hose pump. Turbine's tear-shaped stack is a protective sheath around the actual exhaust duct.



AT FRONT OF ENGINE, viewed here from underneath the pumper, are the air intake and impeller-silencer. The circular silencer is lined with fiber-glass, covered with perforated sheet metal. The impeller sucks in air through the mesh screen around the rim of the silencer.



RADIATOR-TYPE OIL COOLER is mounted at bottom of the engine compartment. When compartment's sides are in place, air can't get in except through the cooler. It is drawn in by suction created above when exhaust from 10-inch pipe enters 14-inch duct leading to the stack on top.

The slant of the stack suggests speed, and that is available in abundance. San Francisco's new pumper has been clocked at 60 m.p.h.—though not within the city, where fire engines are firmly held to a top speed of 35. On a level stretch, it shot from a cold start to 50 m.p.h. in 45 seconds.

But to the Fire Department, more important than sprinting ability are power to pump; power to climb; fast, sure starts; low maintenance costs; brief down time for overhaul. In these respects, the top brass have already been dazzled by the performance of the little Boeing 502 Turbo Chief.

An engineer's dream. The engine is only 41.5 inches long and two feet in diameter. It weighs but 325 pounds. Yet at full throttle it produces 330 hp., ful-

filling the engineer's dream of obtaining one horsepower per pound of weight.

It is only one-tenth as heavy and takes up only one-quarter as much space as a conventional pumper engine. In its standard-size compartment, it looks rather like a small foot in a big shoe.

Its use so lightened the front end of the pumper that the fire truck's builder was able to achieve an ideal weight distribution of one-third up front, two-thirds in the rear.

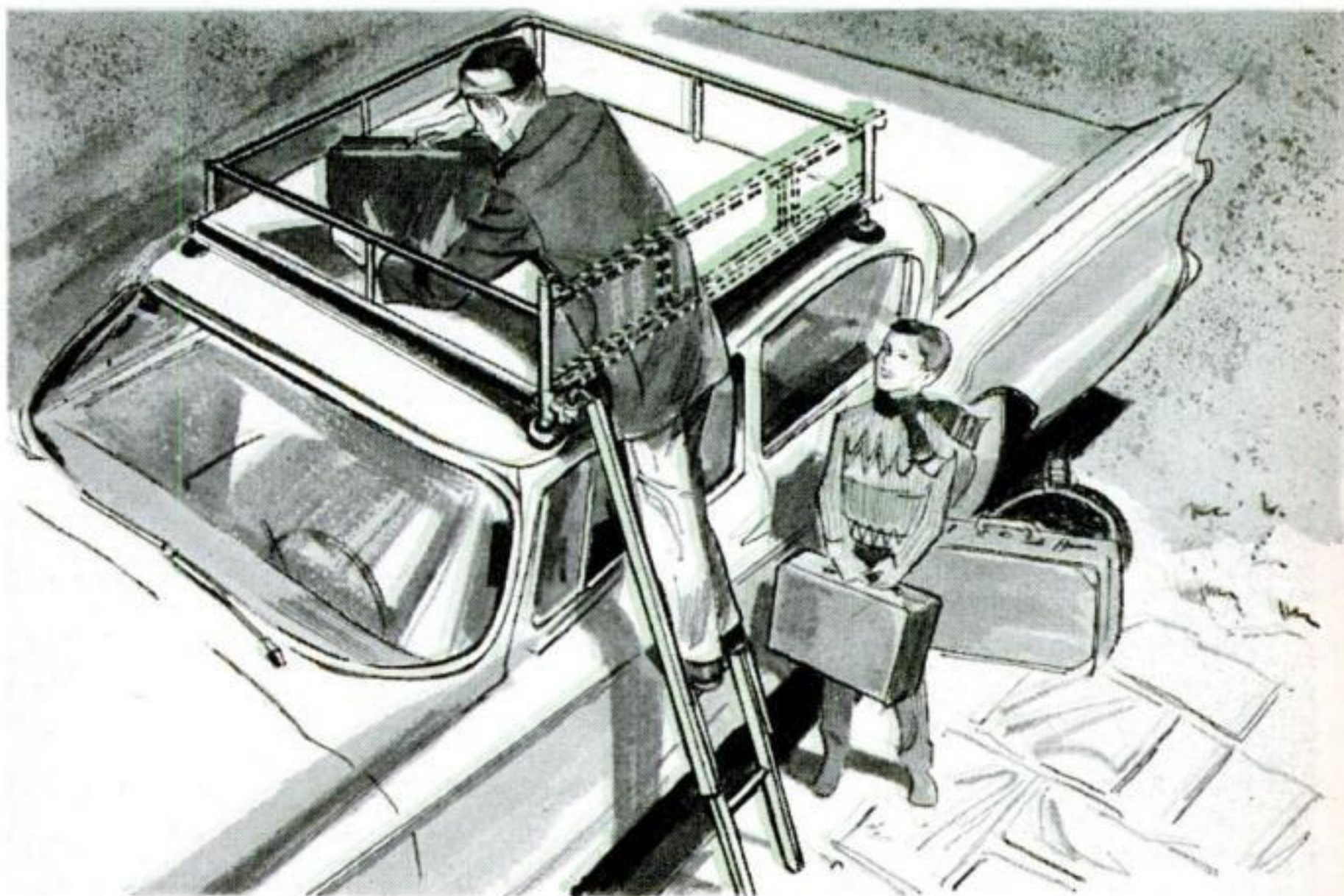
This is a boon to the man at the wheel. "She handles as if she had power steering," said one of the drivers.

After far outpumping all Department rivals with piston engines, the Turbo Chief charged up one of San Francisco's steepest streets—a 20.2-percent grade—

[Continued on page 186]

New Ideas from the Inventors

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Roof Rack Helps You Load. Parallel hinged rails on one side of this recently patented car-top carrier would open out and down, then extend to ground level to

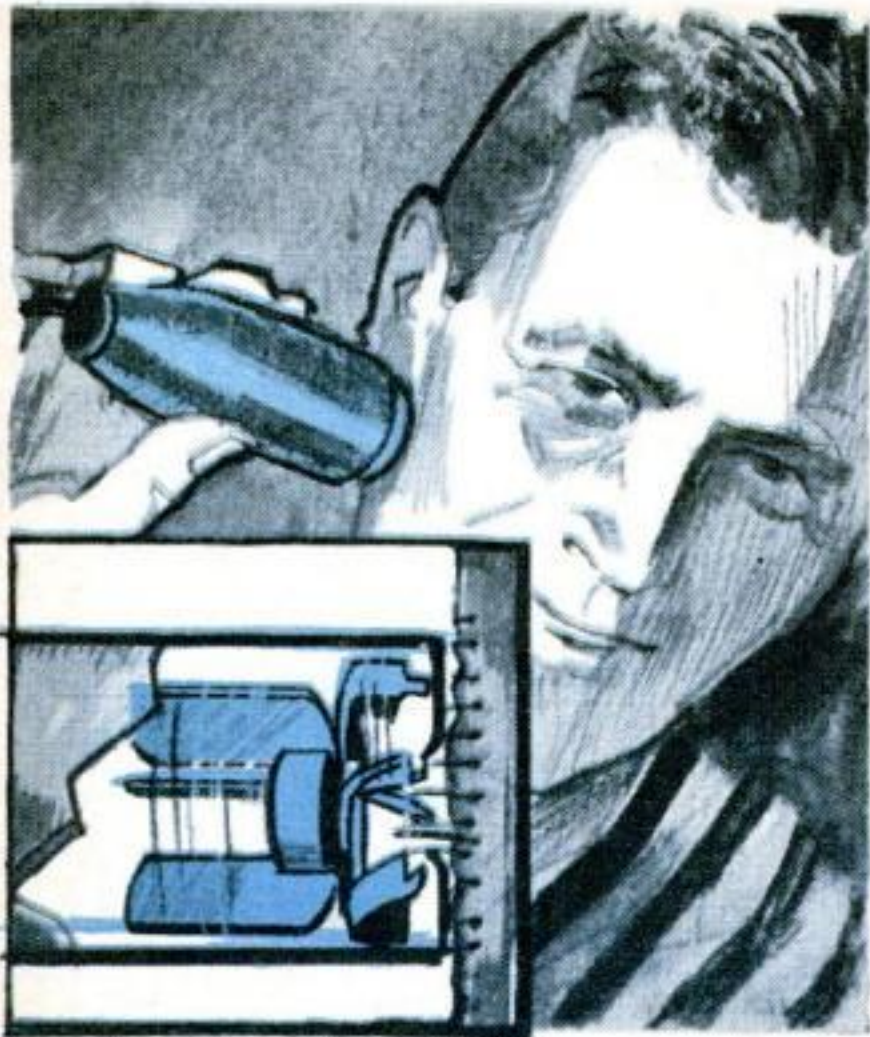
form a ladder. By improving access to the carrier platform, the ladder-side combination would make loading or unloading easier on you and your luggage.

Tray Keeps Toast Warm. Heat rising through holes in this stamped-metal tray would keep your first slice of toast as warm as the last. Saddle-like flanges would fit over a pop-up toaster. To reach the toaster (or serve the toast) you'd lift the tray by its insulated handles.

Cigarette Box Holds Ashes. You'd never have to hunt for an ashtray if your cigarettes came in a box like this. Lifting the box lid would allow the hinged, V-notched, fireproof cardboard front to open out, forming both an ash receptacle and a cigarette rest.



More Inventors' Ideas



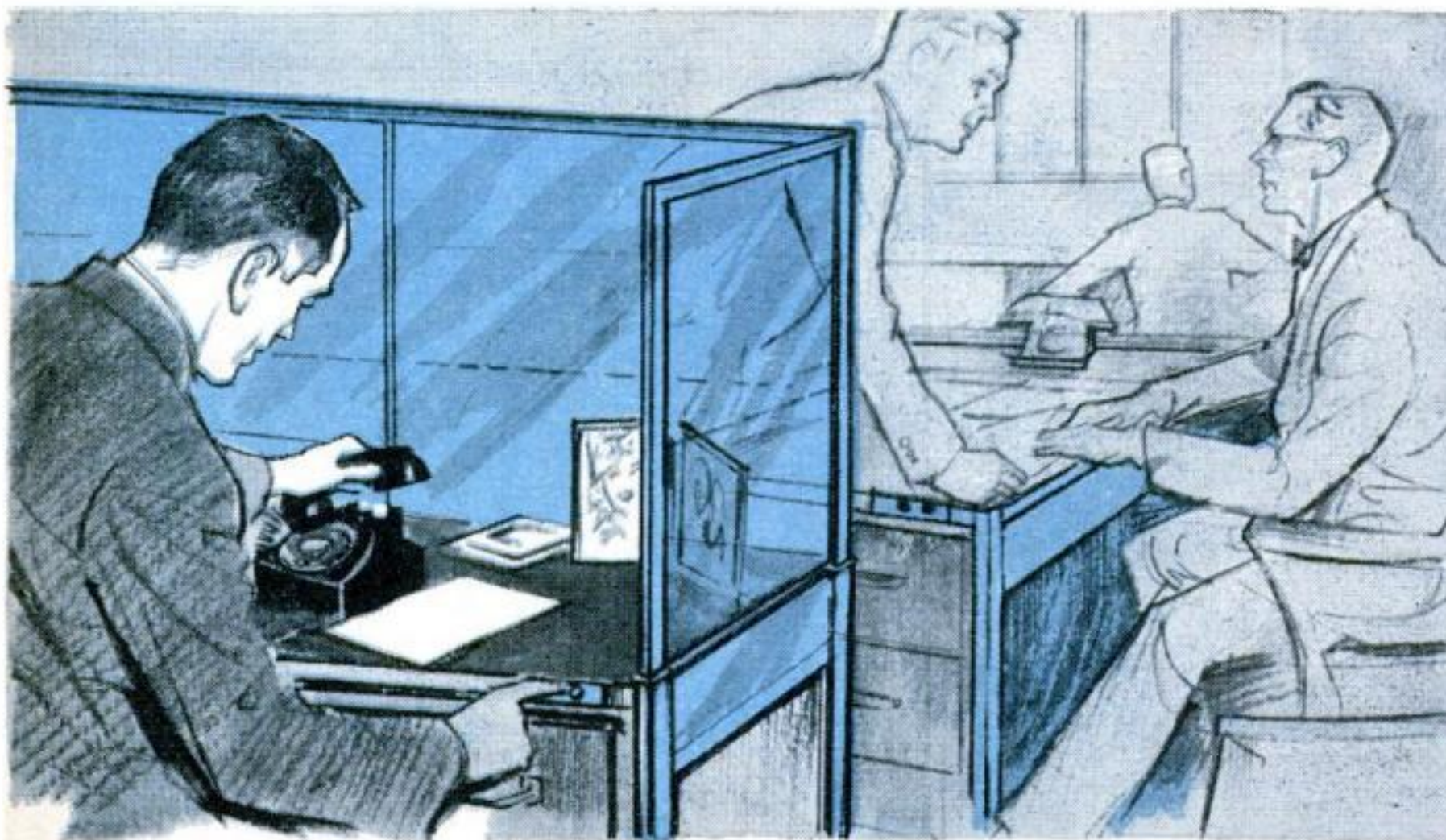
Suction Speeds Electric Shave. Fan-like vanes would set up an air flow in the cylindrical housing of this shaver. The suction, it is claimed, would help draw the hairs into the rotary cutters, giving you a faster, closer shave. Suction would also help clean the razor.



Scraper Keeps Car Clean. Recessed into any automobile door, this fold-down foot scraper would close flush with the door upholstery. A spring latch would drop the brush platform into shoe-cleaning position so that passengers would not track mud and dirt into the car.

Desk Panels Rise for Privacy. Motor-driven panels on three sides of this open-office desk would be raised at the push of a button. The glass partitions could be

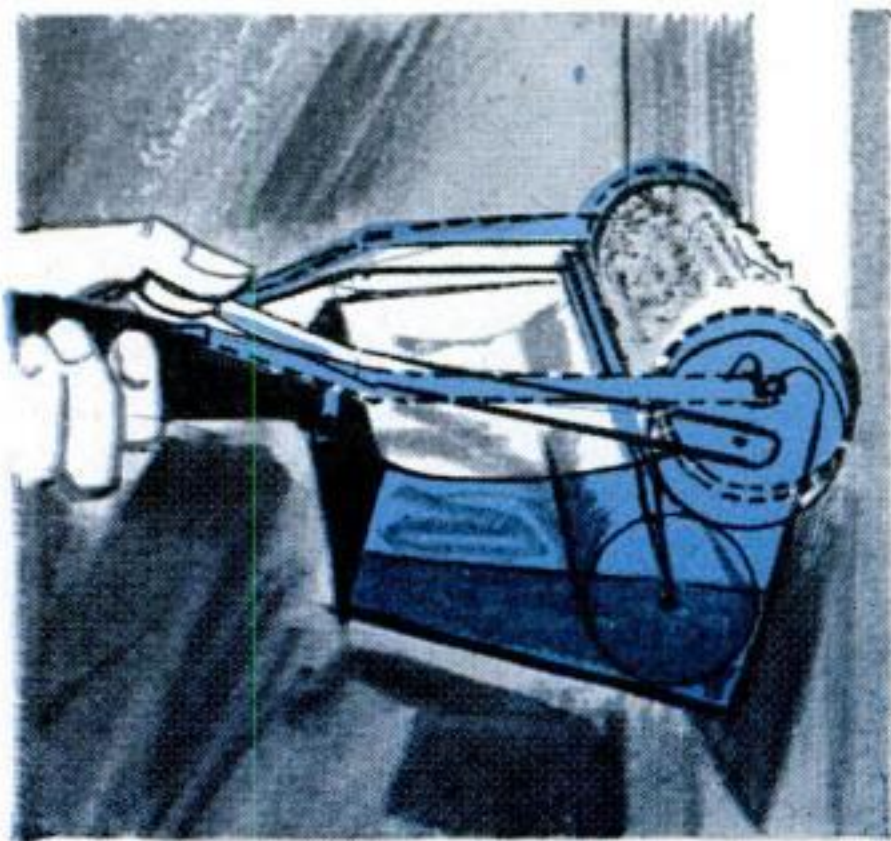
elevated, when needed, to cut distracting outside noises, or to provide greater privacy for both telephone conversations and talks with visitors or customers.





Walking Boot Extends for Wading. A hunter could quickly convert these walking boots into waterproof, thigh-length waders. An extension flap, normally folded inside, would join the inner and outer sections. Loosening the laces would allow the wader section to be pulled up.

Paint Roller Feeds Roller. Two rollers and a reservoir in this applicator would let you paint any flat surface quickly and easily. One roller would pick up paint from the tray. A thumb lever would let you lower the other roller into contact with the pickup, then raise it to apply a uniform paint coat with a smooth and nearly continuous motion.



Platform Cushions Slide Pole. A raised, springy platform at the base of a fire-house pole would cushion fast descents and help speed a crew on its way. Resilient knobs under this foam-rubber platform would bounce a man safely up and off, thus clearing the way more quickly for the next man down.

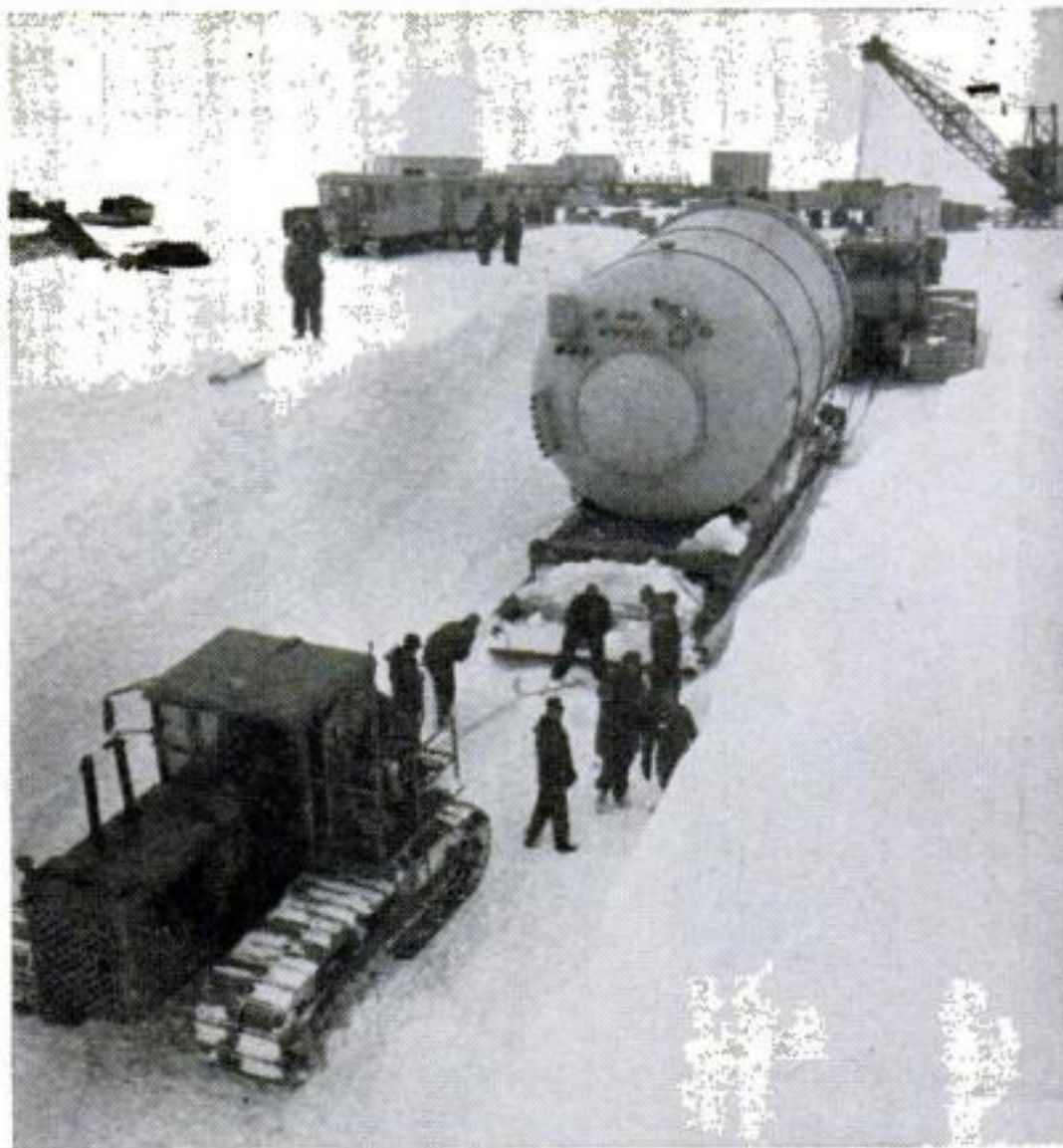
The following patents have been issued on these inventions: Carrier—No. 2,819,005 to J. Roberts, Portland, Ore.; Toast tray—No. 2,828,685 to E. Ogle, Bozeman, Mont.; Ash tray—No. 2,944,555 to C. and D. Peel, Spring Lake, Mich.; Shaver—No. 2,824,367 to A. McWilliams, Chicago; Foot scraper—No. 2,818,594 to D. Dawkins, Alexandria, Va.; Desk—No. 2,944,861 to M. Lessin, Washington, D. C.; Boot—No. 2,824,390 to F. Walker, Framingham, Mass.; Roller—No. 2,824,325 to M. Lussier, Fitchburg, Mass.; Slide cushion—No. 2,945,550 to N. Andreasen, Chicago.

Copies of patents may be ordered, by number, from the Commissioner of Patents, Washington 25, D. C., at 25 cents each. To write to an inventor, if the address given above is insufficient, you may address him (by name and patent number) in care of the Commissioner of Patents.

Atomic power comes to the Arctic

Electricity is now being provided by a modern 1,500-kw. nuclear power plant at Camp Century, the U. S. Army's city under ice [PS, Feb. '60] in Greenland. The plant was prefabricated in 28 sections by Alco Products, Inc., at Dunkirk, N. Y., and the first section flown to the ice cap. The remainder traveled on the Marine Fiddler of the Military Sea Transport Service from Buffalo through the St. Lawrence Seaway to Thule, and from there was hauled by sled train.

The site on which sections were reassembled consists of four long trenches buried under tons of snow. One contains the reactor, vapor condenser, and uranium core; one an air-blast cooler; a third the feed water and controls; and the last the turbine generator. After reassembly last fall, the plant was put through a series of low-power test runs prior to going into full operation.



PULLED BY TRACTOR, vapor condenser for nuclear power plant reaches Camp Century on sledge.



ANGLED CONSOLES are equipped with keyboards to enable trained operators to sort with fingers instead of hands.



TIERED BOXES behind panel can be unloaded without bend or stretch.

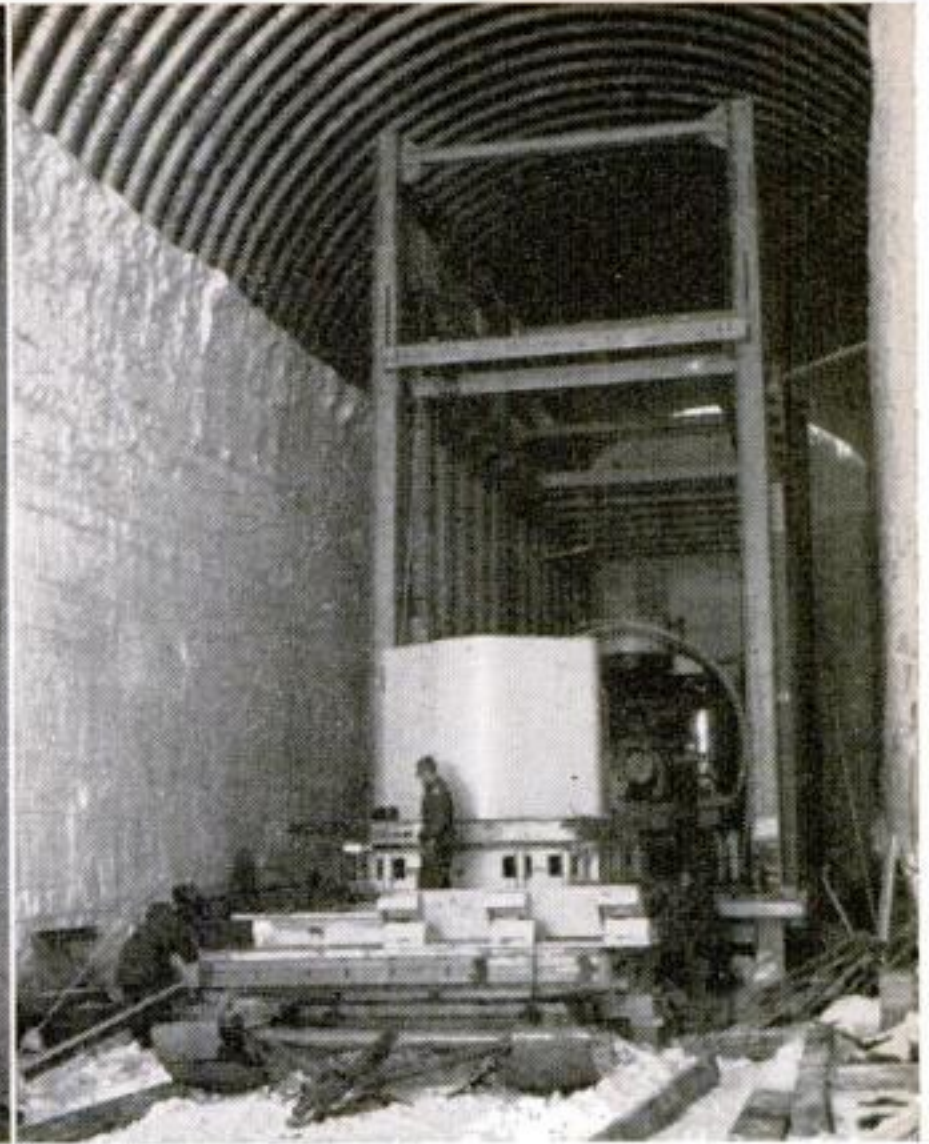
New letter sorter speeds the mail

Handled by 12 operators at keyboard consoles, 60,000 letters can be sorted to 300 destination boxes in an hour. Speed is controlled through an electronic nerve center, and the flow of letters can be started, changed, or stopped at a super-

visor's monitoring panel at one end. The new machine is designed in multiple units to suit the needs of different-size post offices. The first was installed by Pitney-Bowes in a mechanization program at the post office in Washington.



CONDENSER IS MOVED into reactor trench. Man walking beam at top is at original snow level.

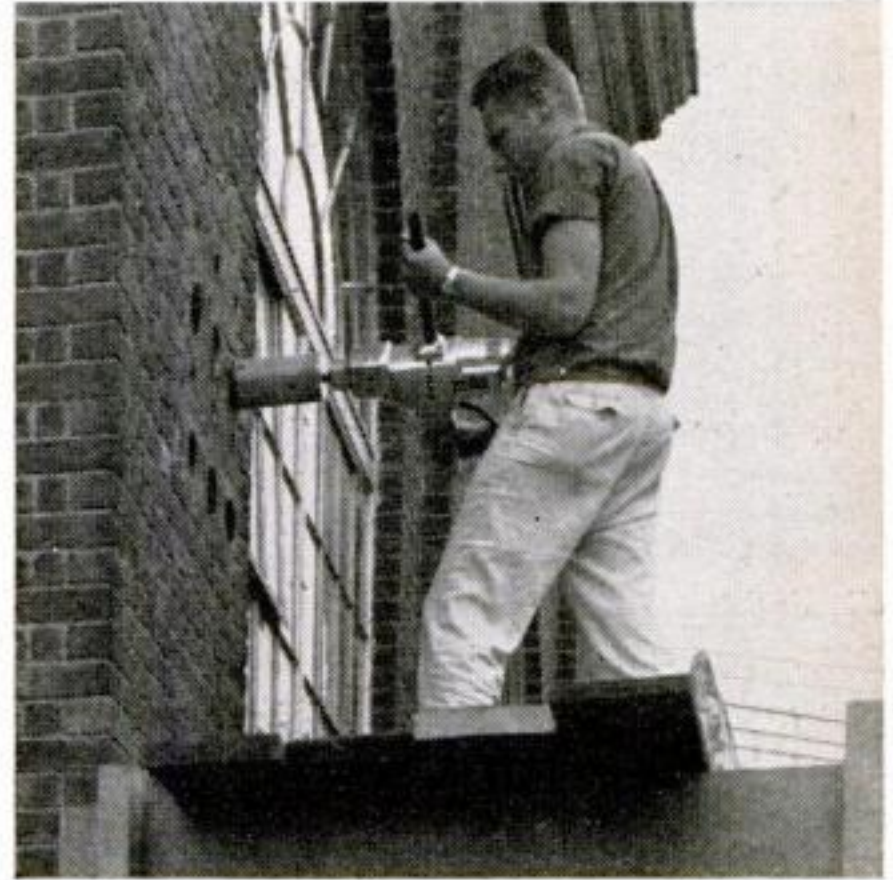


PART OF REACTOR is assembled in trench that will also hold condenser and U-235 fuel core.



Underwater camera

When the propellers of the aircraft carrier Independence were damaged recently, underwater photos were needed before repairs could be made. Since an underwater camera wasn't available, Electronics Technician Edward J. Lamb made his own—out of a conventional 35-mm. camera and a gutted underwater battle lantern. Two valves and a length of wire release the shutter.



Drill cuts four-inch hole

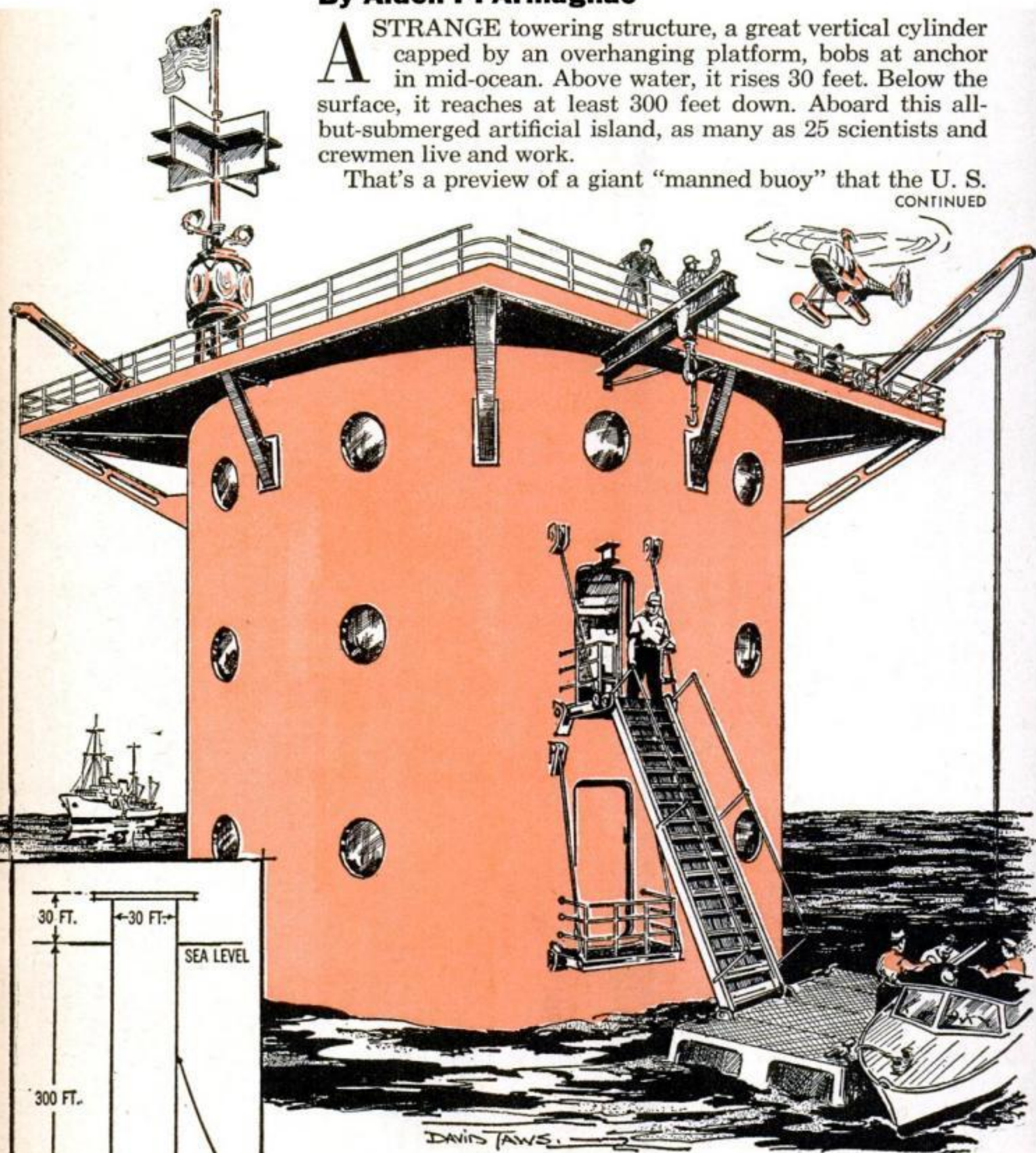
This new electric impact drill is no larger than a $\frac{3}{4}$ -inch tool, but it bores holes from $\frac{3}{16}$ to four inches in diameter in a single operation. It cuts through brick, tile, reinforced concrete, and granite, chewing embedded metal with no hesitation. It's shown here drilling for output cables in the wall of a power station being erected at Bridgeport, Conn., for the Stanley Works, maker of the tool.

Manned Buoy to Probe Ocean Depths

By Alden P. Armagnac

A STRANGE towering structure, a great vertical cylinder capped by an overhanging platform, bobs at anchor in mid-ocean. Above water, it rises 30 feet. Below the surface, it reaches at least 300 feet down. Aboard this all-but-submerged artificial island, as many as 25 scientists and crewmen live and work.

That's a preview of a giant "manned buoy" that the U. S. CONTINUED



ANCHORED IN MID-OCEAN, proposed manned buoy would serve scientists as a sea observatory. Silo-shaped structure, more than 300 feet tall, floats mostly submerged (inset) and more stably than a ship. Deck atop it provides helicopter port, beacon, and radar reflector.

Inside view shows how observers live and work aboard buoy

OBSERVATION DECK AND HELICOPTER PORT

RADIO CENTER AND METEOROLOGICAL STATION

GENERATING PLANT to provide light and power for buoy

ELECTRIC ELEVATOR and stairs

SEA LEVEL

LIVING QUARTERS for 10 to 15 scientists and operating crew of 5 to 10

LABORATORIES for studying biological specimens, analyzing samples of sea water, and other research

OBSERVATION GALLERY for viewing subsea life

MACHINE SHOP AND PHOTO LAB

STORAGE for provisions and laboratory supplies

BALLAST and buoyancy tanks, flooded to up-end buoy after it has been towed horizontally to site

BEACON LIGHT

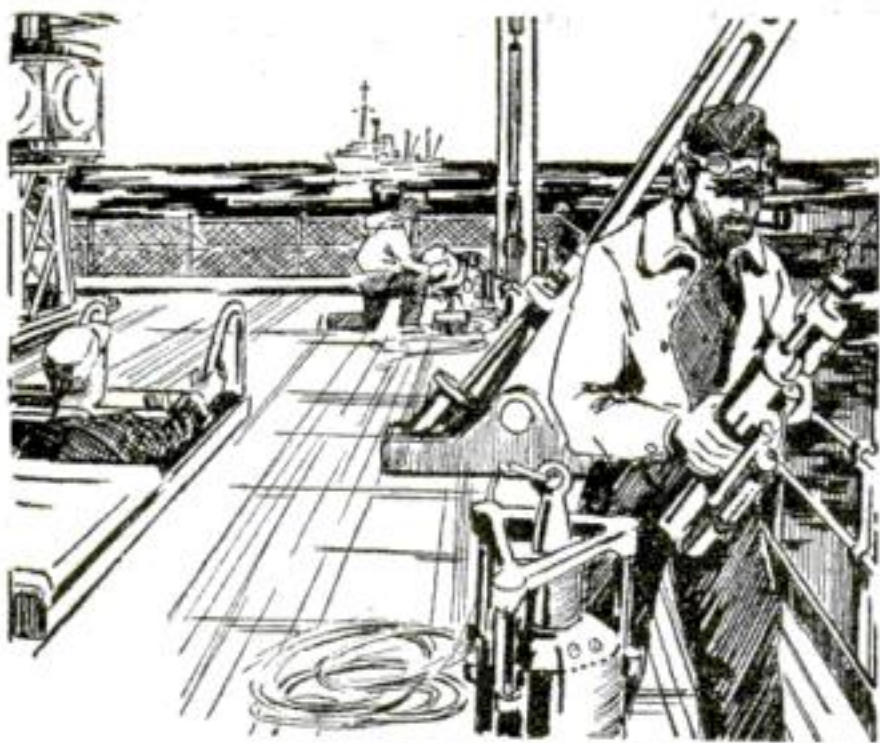
GEAR FOR LOWERING INSTRUMENTS INTO SEA

LANDING STAGE

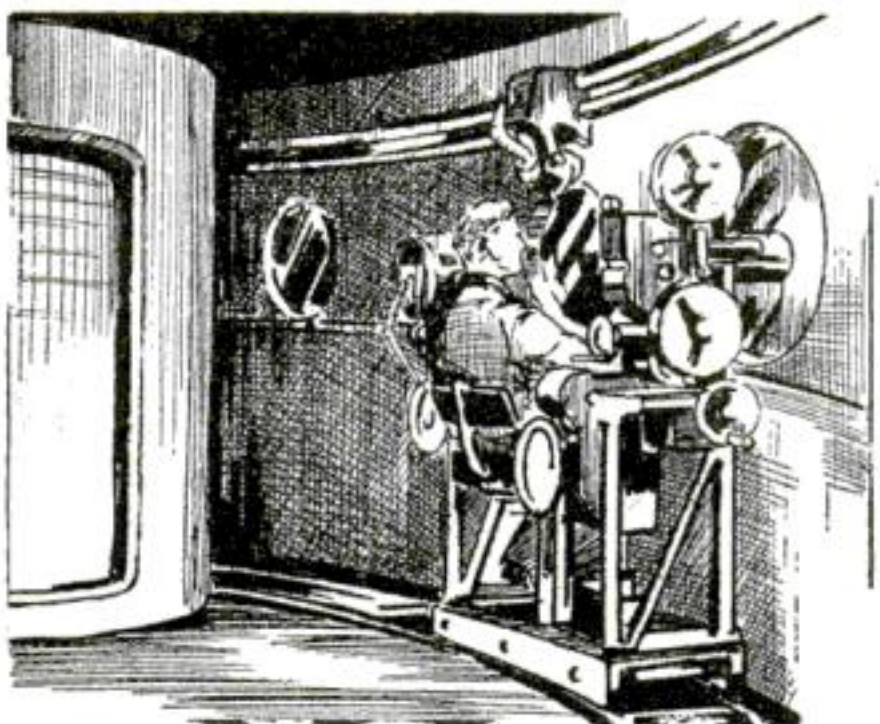
(MORE LABS, OBSERVATION GALLERIES, SHOPS, AND STOREROOMS IN SECTION NOT SHOWN)

UNDERSEA LAMPS ON EXTERIOR OF BUOY

DAVID TAWES



OBSERVERS on buoy's top deck lower instruments into sea to take its temperature, and to collect samples of water, which will be analyzed for salinity by chemical lab in buoy's interior.



SUBMARINE OBSERVATION GALLERY gives view, through portholes, of sea creatures illuminated by lamps outside. Camera truck could roll on circular track from one window to another.



UNDERWATER AQUARIUM could aid study of sea life hundreds of feet down, under natural water pressure there. Tank within buoy confines fish but has a water passage open to the sea.

is urged to design and build for use as an observatory to study the sea. Proposed by the National Academy of Sciences, it would be a prototype for an eventual network of many similar deep-sea observing stations—which NAS' Committee on Oceanography sees as a "standard requirement" for marine research and weather forecasting in the near future.

Drawings on these pages show what the projected \$2,500,000 buoy might look like, according to suggestions by one of the experts of the NAS committee's engineering panel—Dr. Robert Frosch, director of Columbia University's Hudson Laboratories at Dobbs Ferry, N. Y.

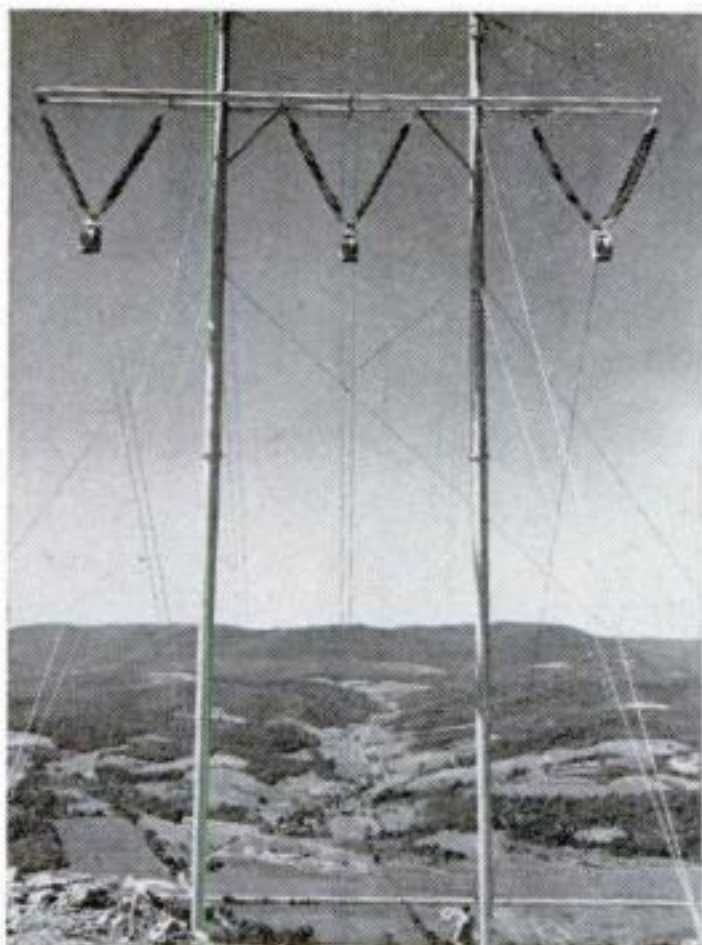
Painted most likely a bright "international" orange for high visibility, the buoy will mount a beacon light and a radar reflector as aids to navigation. Personnel will come and go, and supplies will arrive, on a buoy-tending vessel, resembling an ocean-going tug. To transfer people and cargo, the buoy provides a landing stage, cranes, and hose connections for liquid fuel. Its flat top, an open-air observation deck, also offers a landing place for helicopters.

Inside the silo-shaped buoy, an electric elevator gives access to living quarters, labs, and shops, arranged as pictured on its 25 or 30 levels.

Installed above sea level, lest it hinder delicate underwater-sound measurements, a diesel-electric or gas turbine-electric power plant generates 1,000 to 2,000 kilowatts of electricity for lighting and other uses.

Weather observers will operate a complete meteorological station—equipped to launch balloons and, possibly, upper-atmosphere sounding rockets. Sea scientists will measure and photograph waves, take the sea's temperature, analyze samples of its water, study underwater sound with sound generators and listening hydrophones. They'll lower submarine cameras, TV apparatus, and nets for collecting undersea life. Conducted continuously at a permanent site, these observations should prove far more revealing and valuable than the fragmentary data obtainable by cruising ships.

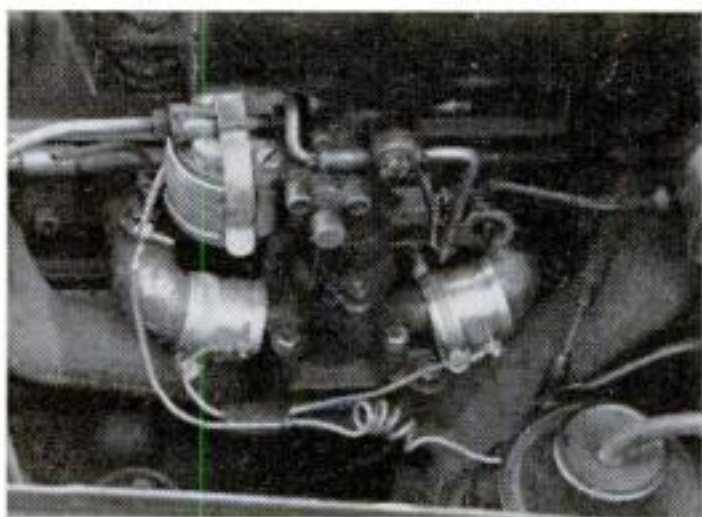
For the first manned buoy, the NAS suggests a choice of three locations: in the Sargasso Sea, off San Diego, or east of the Antilles where hurricanes begin.



460,000-volt line

Extra-high-voltage electricity now flows from ridge to ridge in the Allegheny Mountains. It's a 460-kv. power-transmission line recently put into network operation by the Pennsylvania Electric Co. over 13 miles from Claysburg to Saxton, Pa.

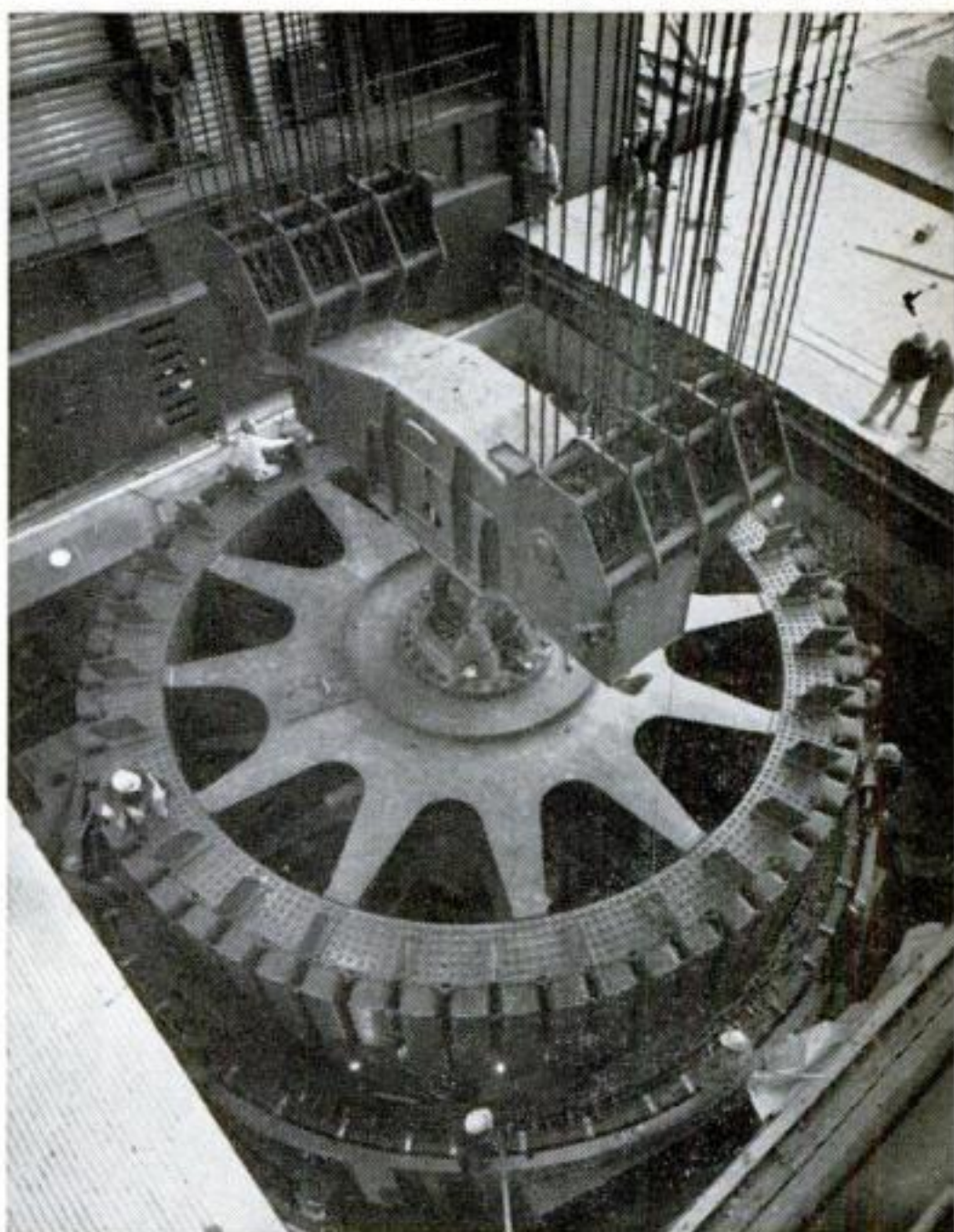
To conduct this ultra voltage, steel-reinforced aluminum cables 2.32 inches in diameter—as thick as a man's wrist—are strung on 15-foot insulators between towers from 60 to 137 feet tall.



Starting a car quickly

Heating elements clamped around the carburetor bowl and inlet manifold assist gas vaporizing and cold starting, minimize use of choke and dilution of oil, and prevent carburetor icing.

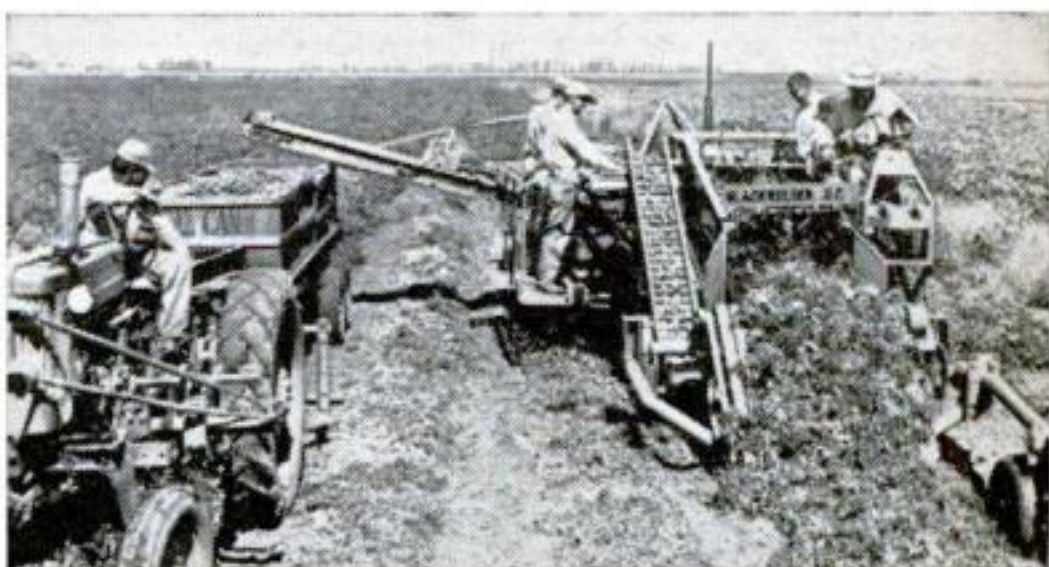
Switched on 90 seconds before a start, the three 12-volt, 50-watt elements in this British device reduce battery drain by eliminating prolonged cranking.



Giant water wheel

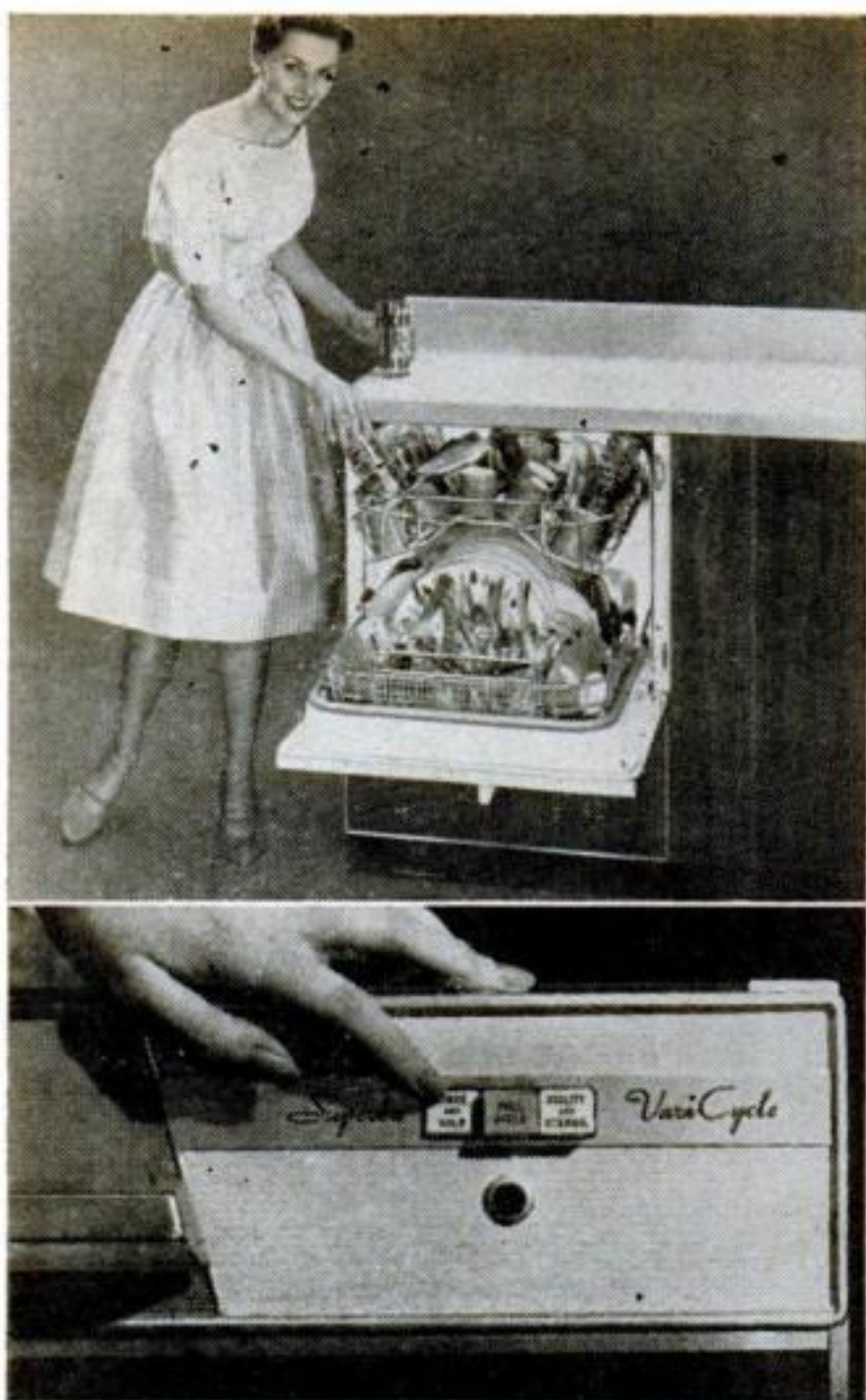
A 500-ton rotor—the first of 13—here is being nestled into its stator by a huge crane at a power plant being built at Niagara Falls. The 35-foot-diameter wheel will rotate in its 150,000-kw. generator at a speed of 120 r.p.m.

First power is scheduled to be delivered this month. When completed, the big plant will be able to generate a total of 1,950,000 kw.



Mechanical tomato picker

This machine can harvest as many ripe tomatoes as 60 men. Tomatoes are picked off the plants by fingers on the straddling device at right as it moves through a field and deposited by conveyor belt into bins pulled by a tractor. The rig was built at the University of California.



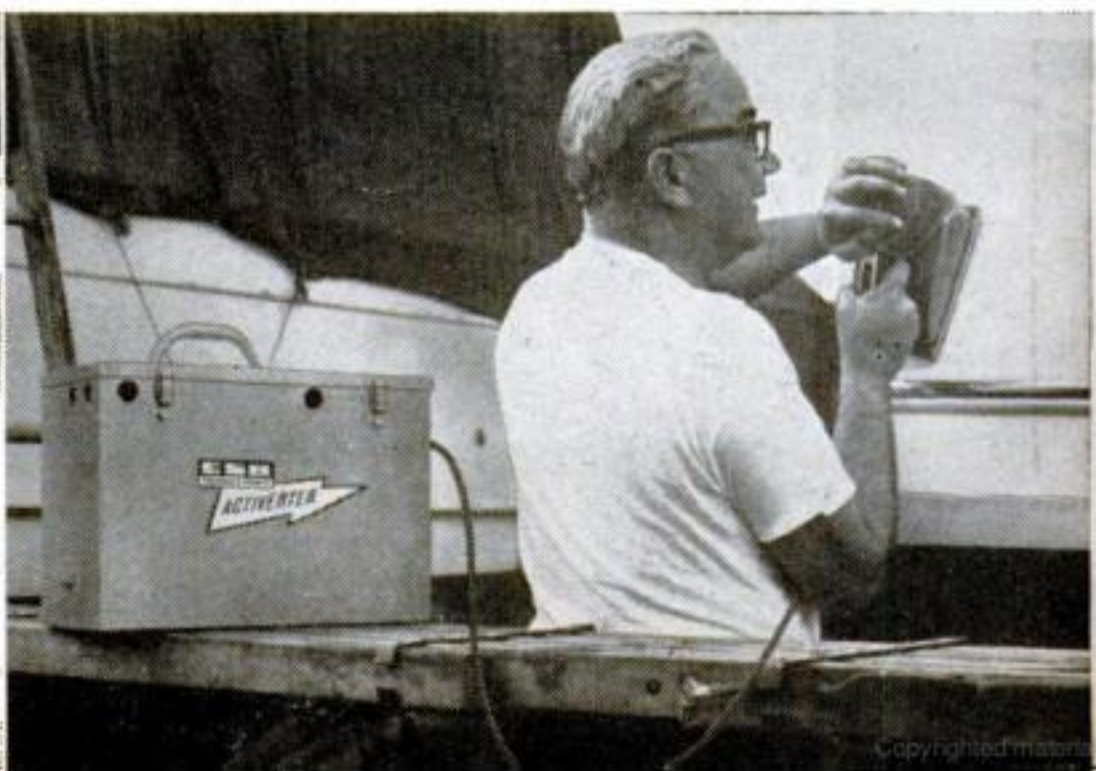
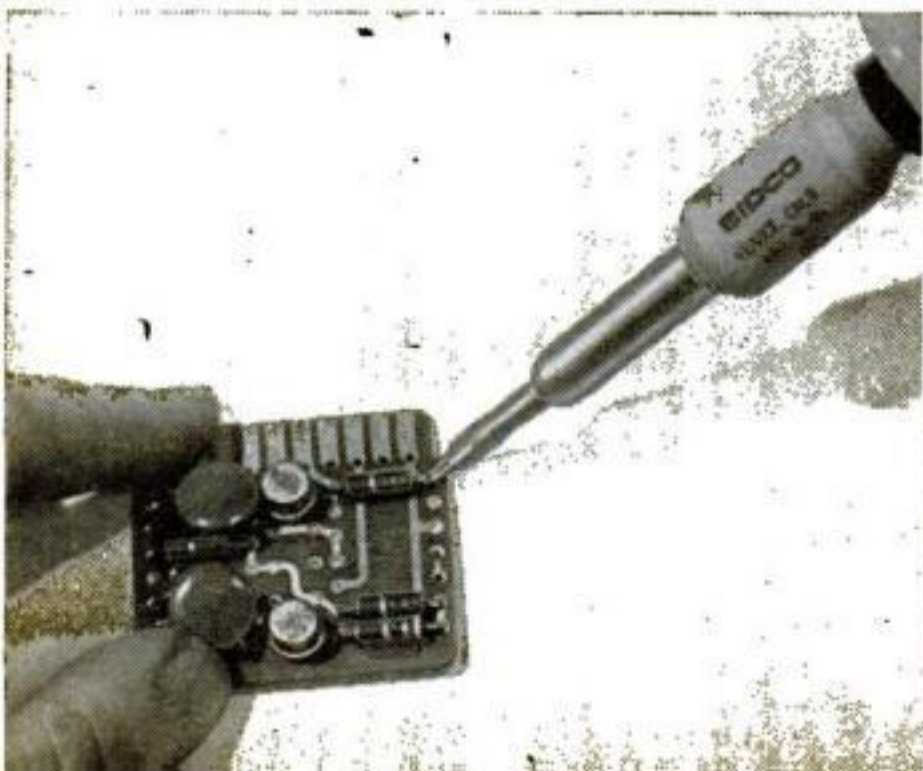
DISHWASHER operates by pushbutton on three cycles. One rinses and then holds breakfast dishes for a fuller load, another handles the full load, a third gives pots and pans extra soaking, less drying. \$360. KitchenAid, Troy, Ohio.

DESOLDERING TIPLET fits into an air-cooled iron (PS, Sept. '60) for unsoldering connections, especially on printed circuits, or straightening bent or folded slugs. A slot grips the wire so you can pull it away when the solder melts. Tiplet is interchangeable with other tips in a heating element. Handle, \$2.50; heating element, \$2; tiplet, 50 cents. SIDCO, Venice, Calif.



AIR CONDITIONER is turned on, off, high, low, or medium by remote control. An amplifier in the unit works, like some TV sets, on signal from wireless transmitter across room. \$499.95. Admiral Corp., 3800 Cortland St., Chicago.

PACKAGE OF POWER contains a battery charger, inverter, and space for a 12-volt battery in a single case. It's called an Activerter and provides 110-volt AC in camps, trailers, and boats for operating your power tools, electrical appliances, lights, TV set, and radio. Without the battery, it's priced at \$149.95. Electric Storage Battery Co., 1717 E. Ninth St., Cleveland.





Dog Sled for Back-Yard Mushers

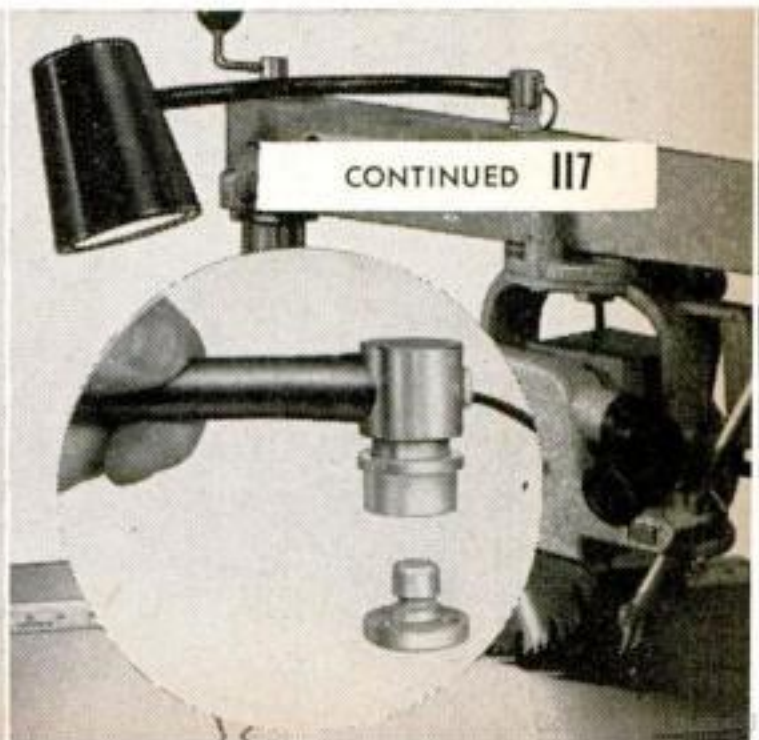
This Yukon-type sled is built of Maine ash to stand abuse. It comes with harness and tug rope, ready to be pulled over snow by your dog, assuming that he's

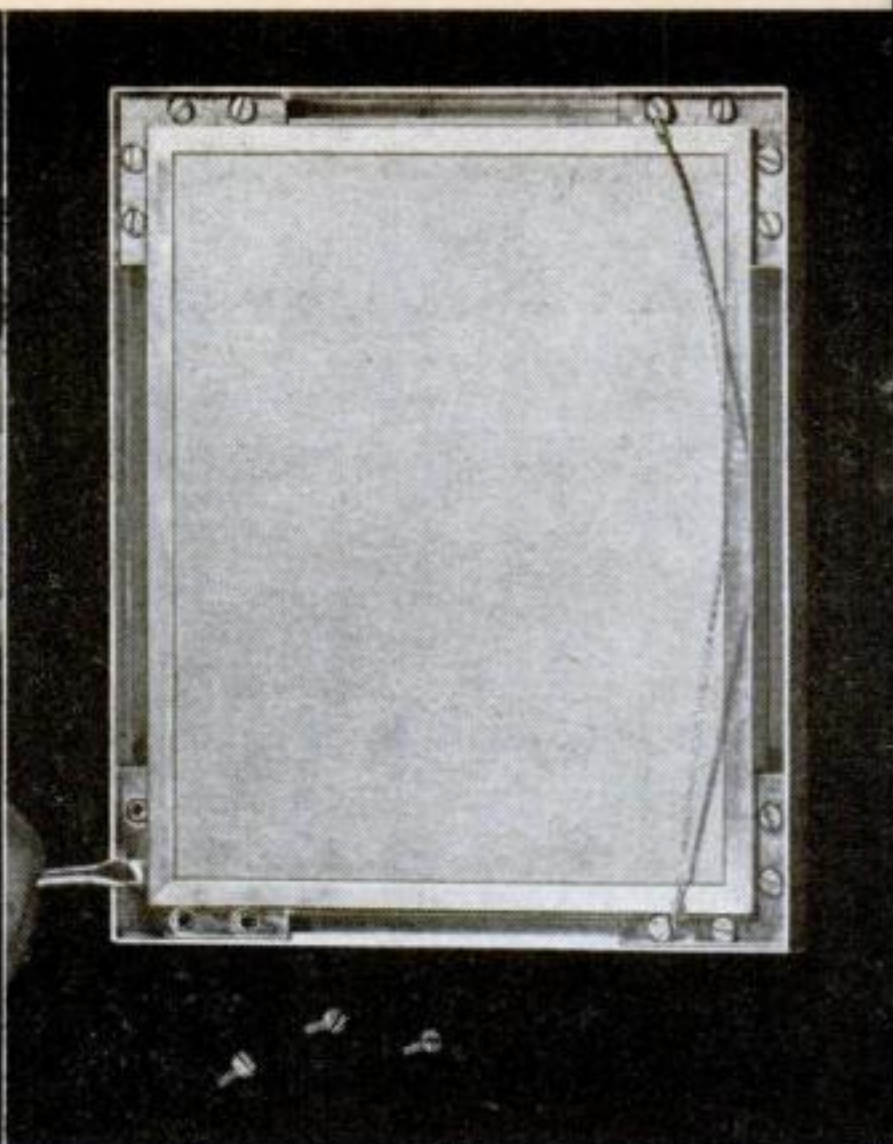
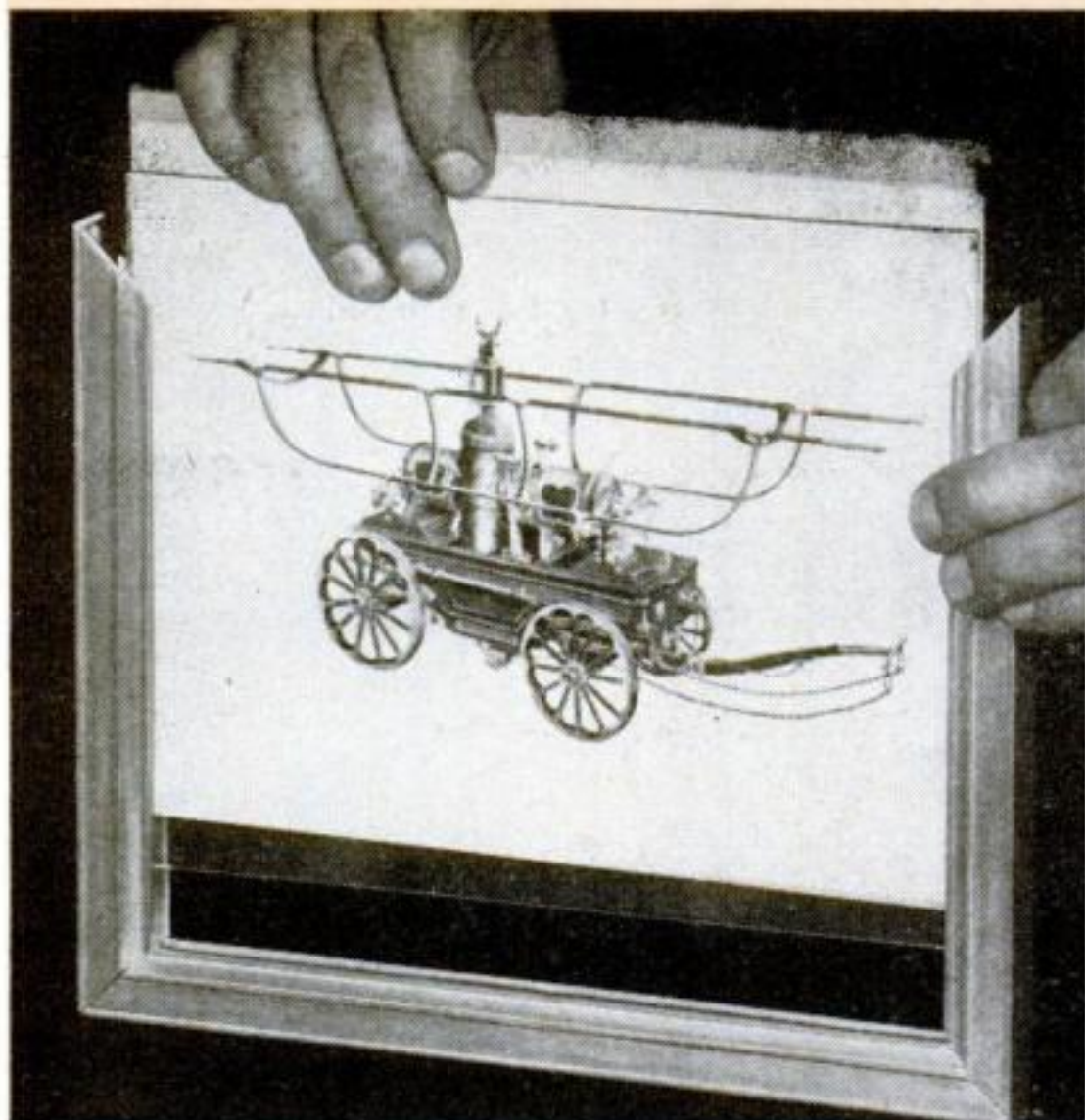
willing. It's 53 inches long and 18½ wide, seats two children on a vinyl-covered pad, with a third standing to drive. It costs \$30. Withington, West Minot, Maine.

EPOXY GLUE is now put up in a divided package with a clip separating measured resin and catalyst. You pull the pin, knead, snip a corner, and apply. Glue comes in clear, white, steel, and aluminum at 79 cents a pack. LePage's, Paper Square, Pittsburgh.

SHINGLE HATCHET has adjustable pin that regulates depth of cut. You insert the pin in half-inch spaced holes corresponding to cut desired. The tool is steel forged in one piece, has a nylon-vinyl cushion grip. \$7.25. Estwing Mfg. Co., Rockford, Ill.

SHOP LAMP mounts on snap-on brackets for individual tools, wall, ceiling, bench, or under your car's hood to give you light where you want it from a single lamp. Plastic or neoprene, \$8.95 to \$12.95. Moffatt Products, Inc., 3124 Washington Ave. N., Minneapolis.





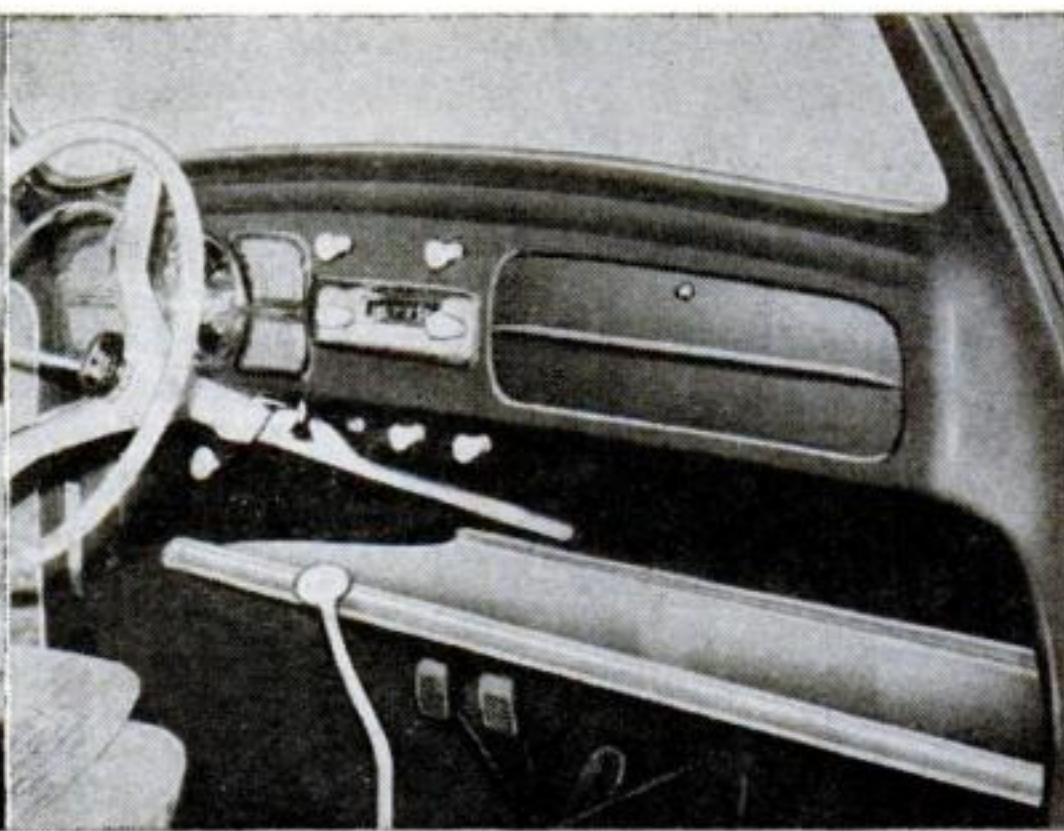
Do-It-Yourself Aluminum Frame

Ornamental channeled aluminum now comes in kits for making picture frames. Each package contains a six-foot length you can cut into an 18-by-18 or 12-by-24-inch frame, plus corner braces, bolts,

nuts, and a project sheet. You miter the ends, slip nuts under a lip in a channel, place the braces on top of the lip, and assemble with a screwdriver. Price, \$3 a kit. Reynolds Metals Co., Richmond, Va.

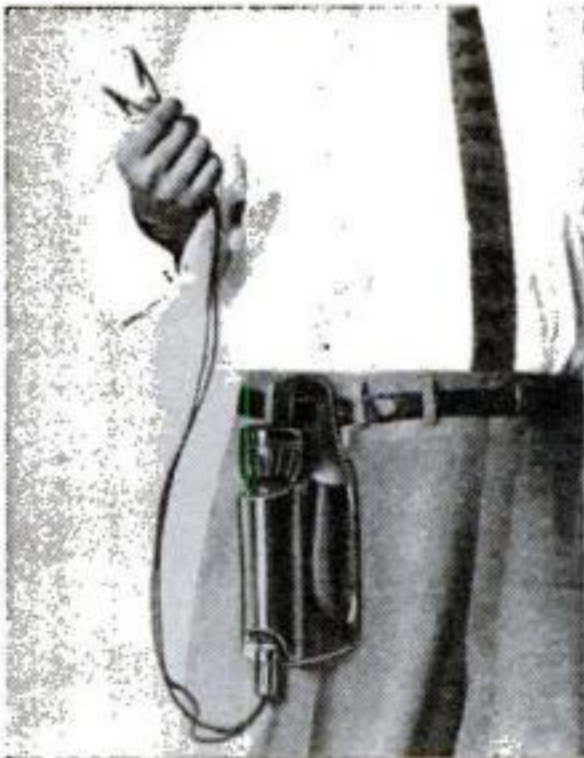


PARKING MINDER is a key-chain timer that sounds an alarm to remind you that your time at a parking meter has expired. You set it by turning an indicator to any time up to 60 minutes. When the pointer reaches zero, a buzzer sounds off. It costs \$3.95. ORCOA, 59 Hempstead Garden Dr., W. Hempstead, N. Y.



UNDER-DASH SHELF is a sheet of vinyl-finished hardboard that wedges between the kick pads at the doors of a Volkswagen (except convertibles) to give you three square feet of extra storage space. To remove for cleaning, just pull it toward you. \$8.95. Powers Mfg. Co., 3632 Montgall, Kansas City, Mo.

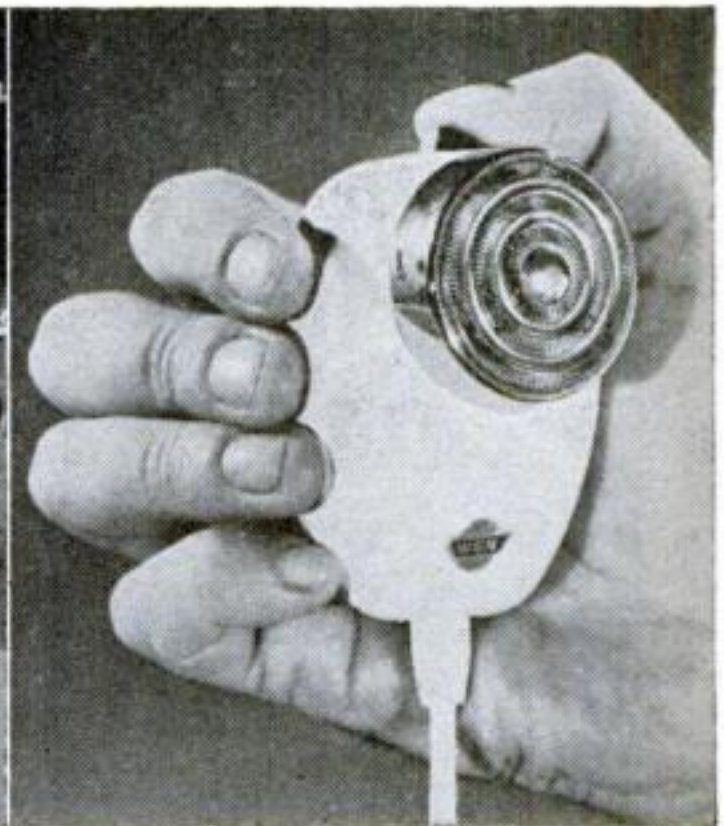
BELT HOLSTER has one pocket for a flashlight and another for a continuity tester, leaves both hands free for you to work on other electrical jobs. Carrying case alone lists at \$1.50; with flashlight and tester, \$7.30. Bright Star Industries, Clifton, N. J.



ARM STRETCHER gives you extra reach for carrying large panels of plywood, hardboard, and glass; or window frames, bed springs, and mattresses. It puts the weight where you can manage it without strain. The handle is adjustable to three positions. Rubber grips on the lower end prevent slipping, or marring of edges. \$5.95. Long Arm, Box 351, Elm Grove, Wis.



TRUCK TARPAULIN fits over a scissor-action frame to protect cargo in half- to one-ton pickup or stake trucks. It rides on runners, can be collapsed against the cab by one man to make unloading easier. It sells for \$198.95. Griffin Research & Design, Ltd., 2018 Seventh Ave., N.W., Calgary, Can.



ROTARY SHAVER is made by the manufacturer of a well-known line of portable electric tools. Small and easy to handle, it runs on a commutator-and-brush motor having extra-long brushes that do not need adjustment. Cutter is permanently mounted. \$19.95. Wen Products, 5810 Northwest Hwy., Chicago.

How a Limited-Slip

UNTIL early horseless-carriage makers remembered an even older invention, they either drove only one wheel or skidded around every turn.

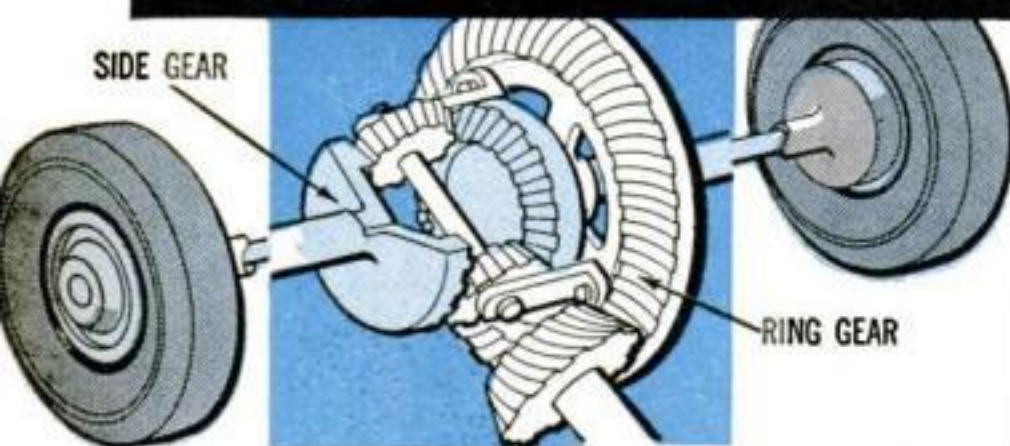
In 1827 a Frenchman named Pecquer had devised a gearbox that drove two separate wheel axles equally, yet allowed one to turn faster than the other on curves. We still use it. But if one wheel spins on mud or ice, the differential turns only that one, letting the other stand.

A limited-slip differential uses, besides Pecquer's box of tricks, automatic clutches that reverse its bad habits. If a

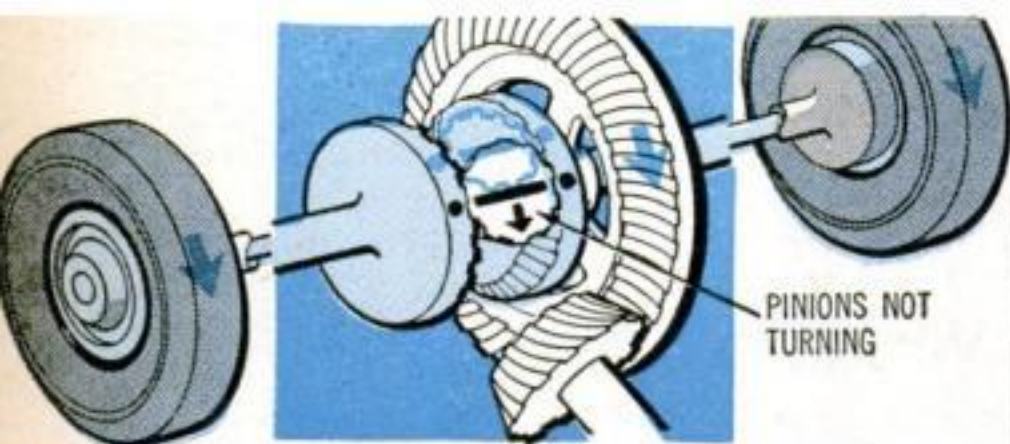
wheel slips, its clutch resists its spin and proportionately more (instead of less) torque is shifted to the other wheel.

Even with both wheels on ice, such a differential favors the one with slightly more grip. If neither holds, the driver puts a tire chain on only one wheel; the differential will route torque in its favor. Or, if the hand brake works directly on the rear wheels, he can apply it part way. This synthetic load tricks the differential into sending the wheel with better traction up to five times as much torque as the other.

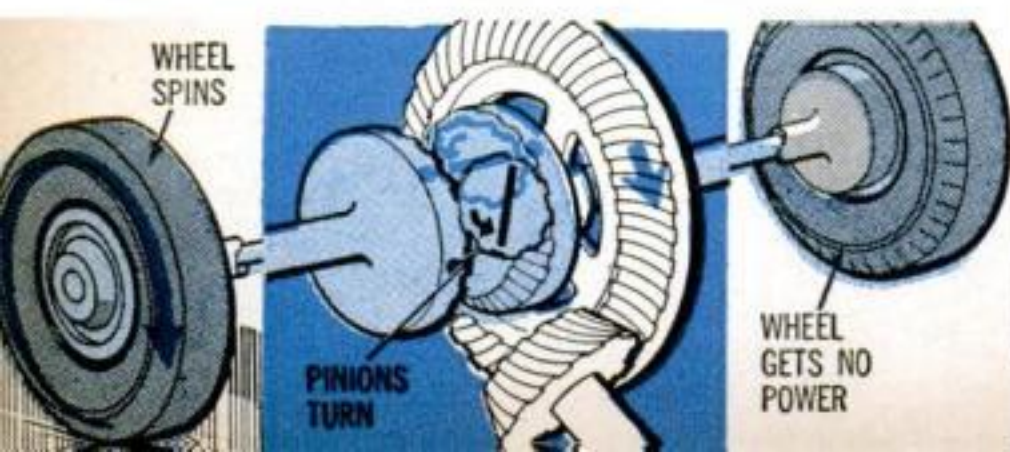
What a differential does



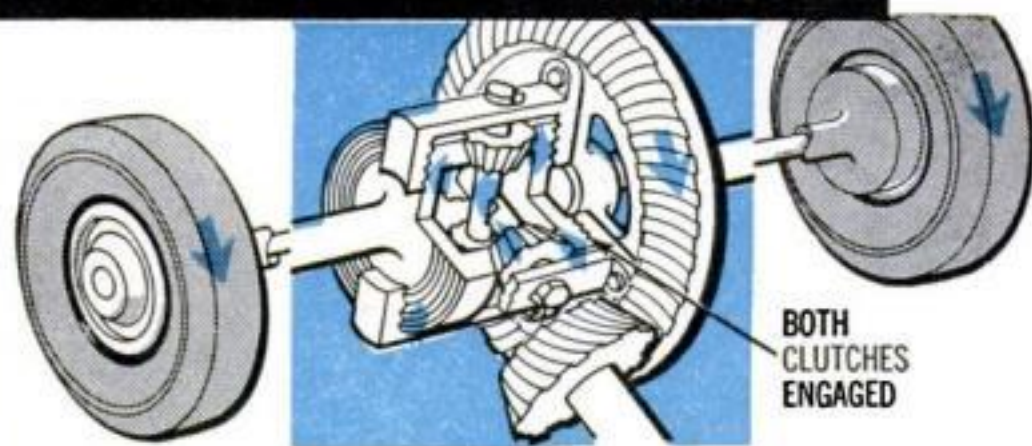
DRIVE-SHAFT PINION turns the big ring gear, on which is mounted the differential cage (here shown diagrammatically as two brackets). The cage carries around a cross shaft with two small pinions free to turn on it. These constantly mesh with two side gears, one on each of the two entirely separate wheel axles.



ON STRAIGHT ROADS, the pinions act like bars connecting the side gears (above) and pull them around at equal speed. But on a curve or with a wheel on ice (below), the greater resistance of the gear on the road-loaded side makes pinions roll around it. Rotating, they turn the free-side gear proportionately faster.



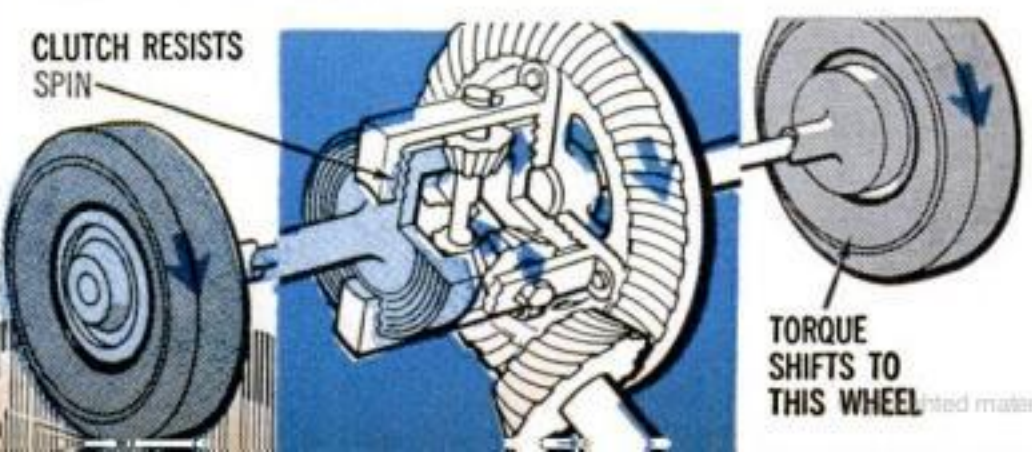
Clutches shift the power



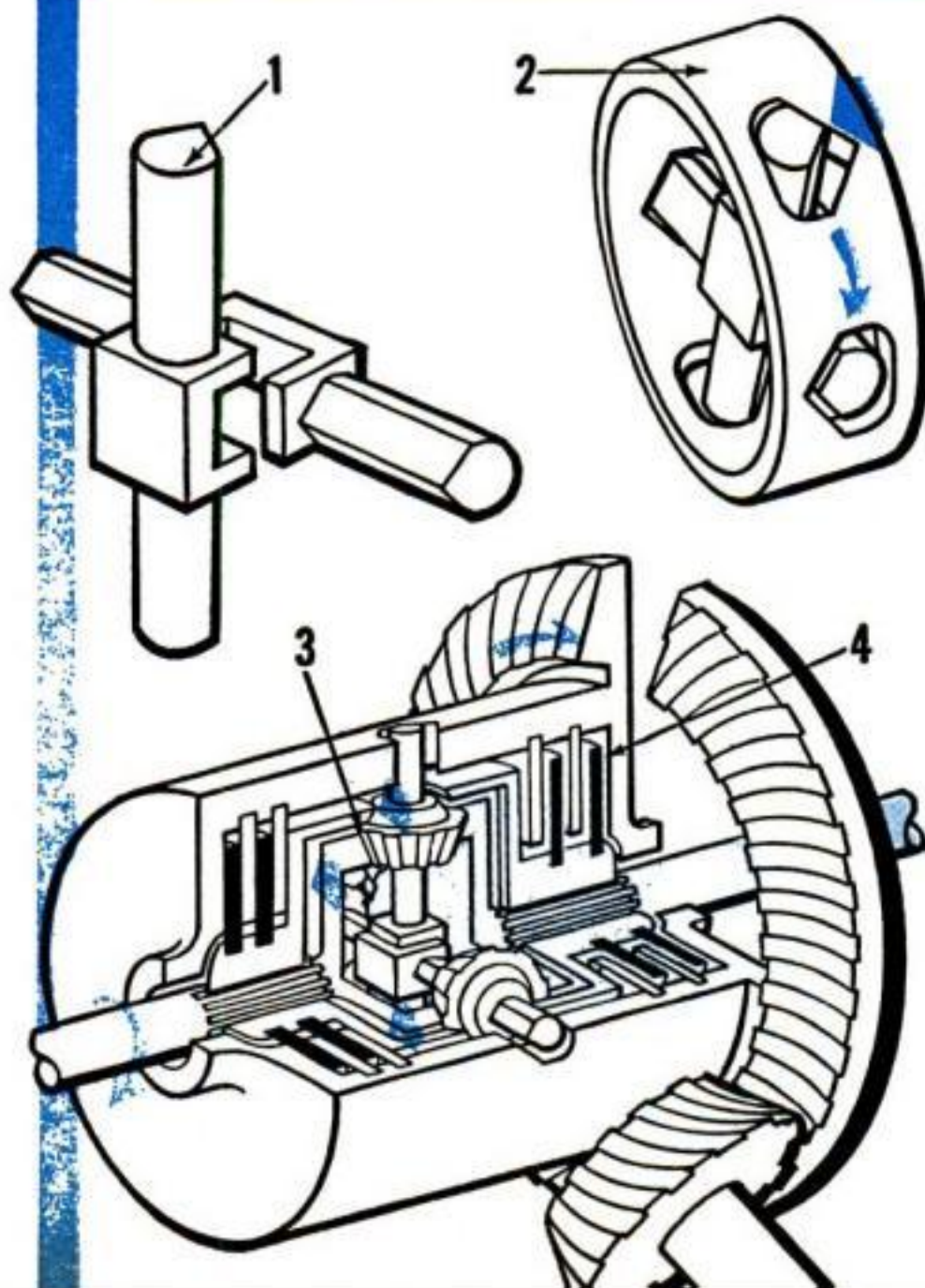
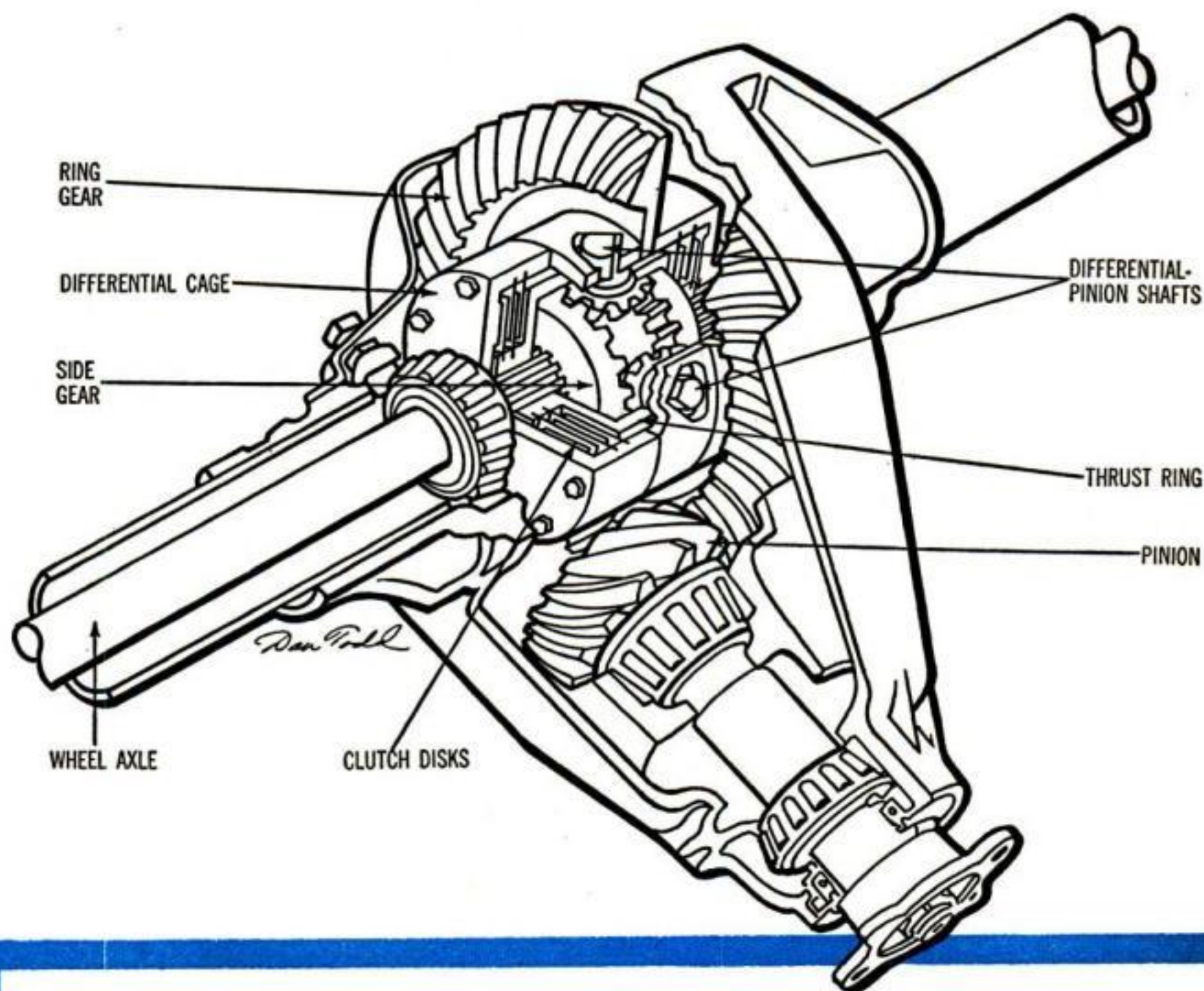
LIMITED-SLIP DIFFERENTIAL has the same gear setup but with four differential pinions, plus a clutch on each side. One set of clutch disks is keyed to the differential cage; the other disks are splined to the wheel axles. In straight going, both clutches are engaged, preventing wheel-slip on bumpy roads.



IN TAKING A CURVE, the outer wheel over-speeds the cage. This slackens pressure on both clutches, letting them slip so that the wheels turn independently. But if one wheel spins on ice (below) the clutches act like a one-wheel brake, counteracting the differential's action and transferring power to the other wheel.



Differential Works



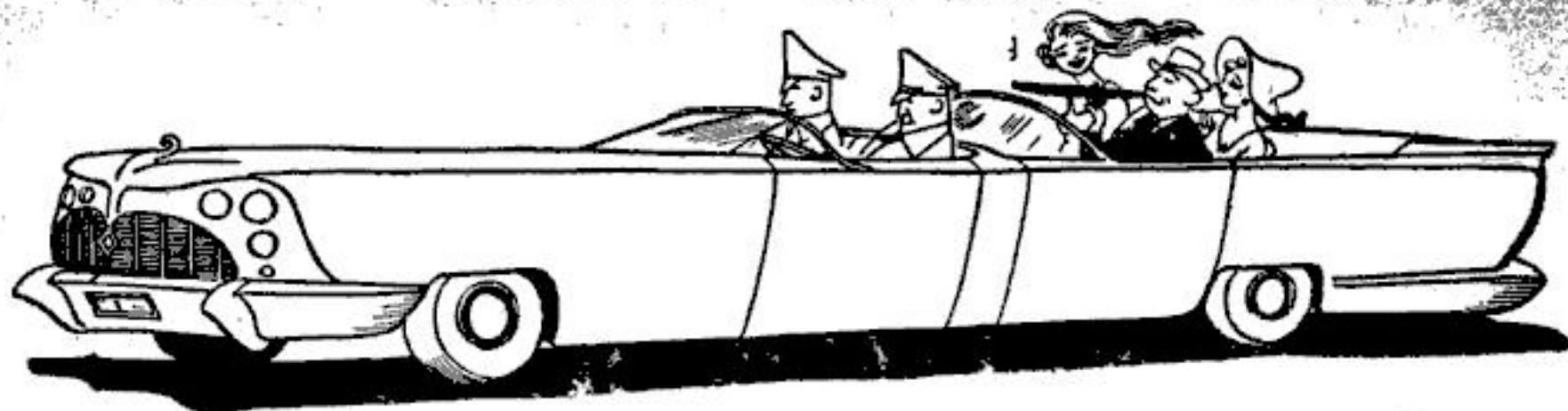
Floating pinions sense road load to control clutch action

1 TWO CROSS SHAFTS that carry the differential pinions are loosely joined at the center. Outer ends of shafts are V shaped, with V points of one opposite those of the other.

2 HOLES IN DIFFERENTIAL CAGE have internal Vs or cam surfaces matching those on shafts. As cage turns, wheel resistance makes cross shafts lag. Drive torque forces V ends up cams, pushing shafts and pinions outward.

3 MOVING OUT, pinion shoulders bear on a thrust ring that squeezes the clutch disks together (arrows, left). Effect of clutches is to drive wheels directly from the cage, whether car is accelerating or decelerating.

4 OVERRUNNING OUTER WHEEL on a turn makes pinions rotate and try to overspeed the cage. This torque reversal backs shaft ends off cam ramps, easing clutch pressure. Clutches slip and differential acts normally. But if a wheel spins on ice, torque driving it engages both clutches, creating drag between wheels and cage. This resists spin of slipping wheel, transfers torque needed to spin it (and that to slip the clutches) to wheel with traction. Differential above is made by Dana Corp.



STRAIGHT TALK TO INVENTORS: 1

So You've Invented Something... Now What?



It is still possible to make a million with a fresh idea. But with 50,000 patents being ground out every year, not many inventors ever hit real pay dirt.

With this article, POPULAR SCIENCE begins a new series that will interest

every man who ever dreamed up something new and useful, and who wants to protect his valuable idea and turn it into cash in the bank.

This month, read how to go about marketing your invention. Next month: "What Should I Invent?"

By Martin Mann

THE Great American Dream is to invent something that will make a million dollars. Lots of people realize the invention part of that dream. Every week the U. S. Patent Office issues 1,000 magnificently engraved certificates attesting to it. Some of them make money. A few hit the jackpot.

George Nelson, for example. In 1940 he was a mechanic bolting down deck plates in a San Francisco shipyard. Too slow for wartime. So he invented a flux-filled stud, and a semiautomatic gun for welding the stud to the ship's frame. Together they eliminated a finicky drilling and tapping operation.

The next year Nelson got three patents. By 1942 he was the Nelson Stud-Welding Corp. He hit up his friends for \$16,000, sank \$4,000 of his savings, and

borrowed several thousands more. And the Nelson Stud-Welding Corp. almost went broke.

One year later, however, the gross exceeded a million. In 1944 the company was sold for \$15,000,000. Nelson's personal share: \$3,000,000.

So it does happen. Independent inventors—bucking the degree-loaded research teams in laboratory palaces—get two out of every five patents. More surprising, they win the lion's share of the valuable patents. Sixty percent of the important inventions come from the loners working at home or in small companies.

Two young musicians started working on what became Kodachrome color film in the bathroom of a New York apartment; one employee of a two-bit St. Paul company invented Scotch tape; an obscure RAF officer created the jet engine;

a couple of lab men at a small fabric-printing outfit in England discovered Dacron.

The stakes are high—and so are the odds against you

There's a dark side to the picture, too. So many new ideas are born, and the struggle for acceptance is so fierce, that all but a very few inventions languish and die without earning a nickel.

One respected broker, who has built a profitable business for himself by promoting other people's inventions, confides that he serves about 1,000 clients a year. On the average, he completes a sale for three of those hopeful 1,000.

A good invention is only the beginning

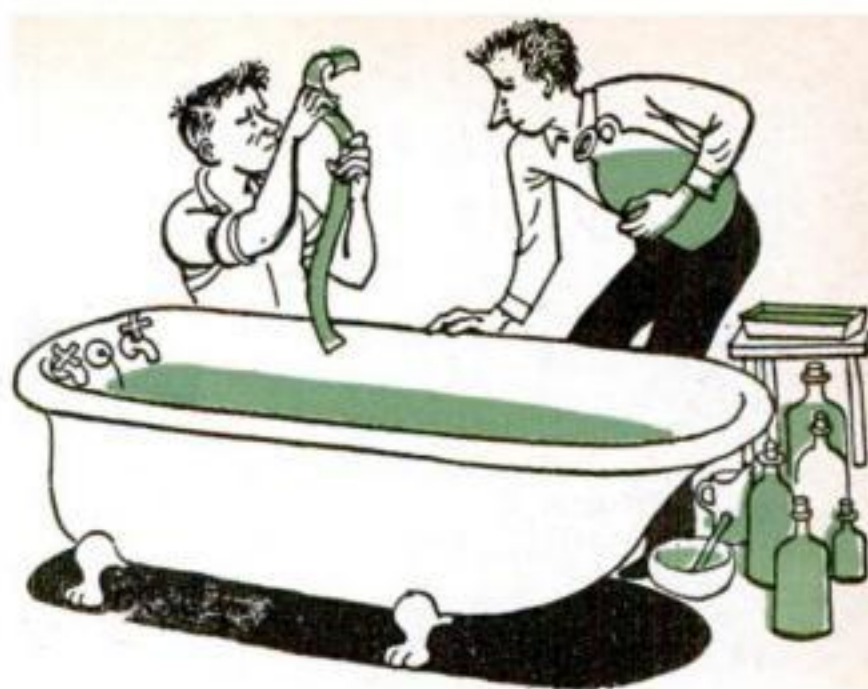
You have to start with a good invention. (Naturally yours is.) But that's the small part of the job. Commercializing it requires more ingenuity and hard work than the original invention did. Today public and private agencies are anxious to help you. New products and processes are in greater demand than ever before.

Uncle Sam offers inventors a helping hand

At least three Federal agencies make an effort to help independent inventors:

The Patent Office, besides offering advice on patent procedure and a roster of patent attorneys, makes a stab at publicizing inventions. When your patent is issued, it is described in the widely read Official Gazette. For \$3, you can have it summarized in a special list of patents available for sale.

The Small Business Administration



Two young musicians started working on Kodachrome color film in the bathroom of a New York apartment.

(local offices in several cities) gives advice and also publishes a listing of inventions for sale.

The National Inventors Council (Washington 25, D. C.) hunts ideas for the Armed Forces, which take over the development of the promising ones.

But how do you go about selling it?

Anyone who counts on Government listings to fix him for life with royalty checks is more likely to end up broke. A successful inventor has to be a persistent salesman.

You can advertise your invention (*Wall Street Journal*, *New York Times* Sunday financial section), but cheaper and closer to the bull's-eye are letters direct to manufacturers (address the patent department). Your chances? A survey of top patent counsels by the industrial magazine *Design News* revealed this:

You'll get polite consideration from two out of three companies. However, only one in six encourages outsiders to

In 1940, George Nelson was a mechanic bolting down deck plates in a San Francisco shipyard. Too slow for wartime. So he invented a welder.





Anyone who counts on government listings to fix him for life with royalty checks is more likely to end up broke.

submit ideas, and a bare 1 in 20 actively solicits them. Among the least receptive: automobile and airplane manufacturers.

Choosing the right company to approach

This is probably the biggest secret of success in marketing your invention. The pros go after firms that can *sell* the product, not the ones equipped to manufacture it. A leather-goods outfit will be less interested in a new idea for tool cases than a tool manufacturer. The tool company already has customers for the cases, and gets somebody to make them up.

This problem solves itself if you invent an improvement for a standard product. Jacob Rabinow, the inventive genius who developed the magnetic clutch, knew where to offer licenses for his self-adjusting watch movement (a tricky linkage automatically resets the regulator every time you correct the hand setting). Only watch and clock makers would be interested. They were. It is now a feature of many wrist watches and auto clocks.

Things worked out differently for Walter Haskins. He was sick in bed one day, but kept busy on the phone. While juggling phone directories, he thought up Redyref—the rack that suspends a row

of books on a rod so that any one book can be swiveled up to flop open, atop the backs of the others. The obvious customer for this invention was the telephone company (for the rows of directories at busy public booths).

Haskins made his pitch and was cold-shouldered. Not only that, but when he sold a few to hotels and offices the phone company angrily ordered them removed. One building owner retorted that if Redyref went, the phones went, too, winning that skirmish. But total victory didn't come until Haskins interested W. & J. Sloane, the home-and-office-furnishings outfit. One of its big customers is AT&T. Having sold the firm that already served his ultimate consumer, Haskins had it made.

One way: spend money to make money

Invention brokers will take on the job of pushing your idea for you. They usually charge a flat fee (\$75 to \$100) plus a small commission on the sale. The honest ones (and there are plenty of the other kind) tell you frankly what they do for the fee: circularize manufacturers who might be interested, follow up on those who respond to the inquiry, and finally attempt to close a deal.

This panned out for Fred F. Cannon. A small-scale contractor, he invented a post-hole digger, built a couple for his own use, and found that they saved time and man power. As soon as the patent was issued, Cannon signed up with K. O. Kessler of Fremont, Ohio, one of the better-known brokers.

Kessler's staff mimeographed a page-long letter describing the digger, and sent copies to some 30 prospects culled mainly from a private file. Most (including the Government's National Inven-

[Continued on page 191]



The fat cats are ready and eager to ante up because of the way the Federal income-tax laws work out.



Parking meters flower in season

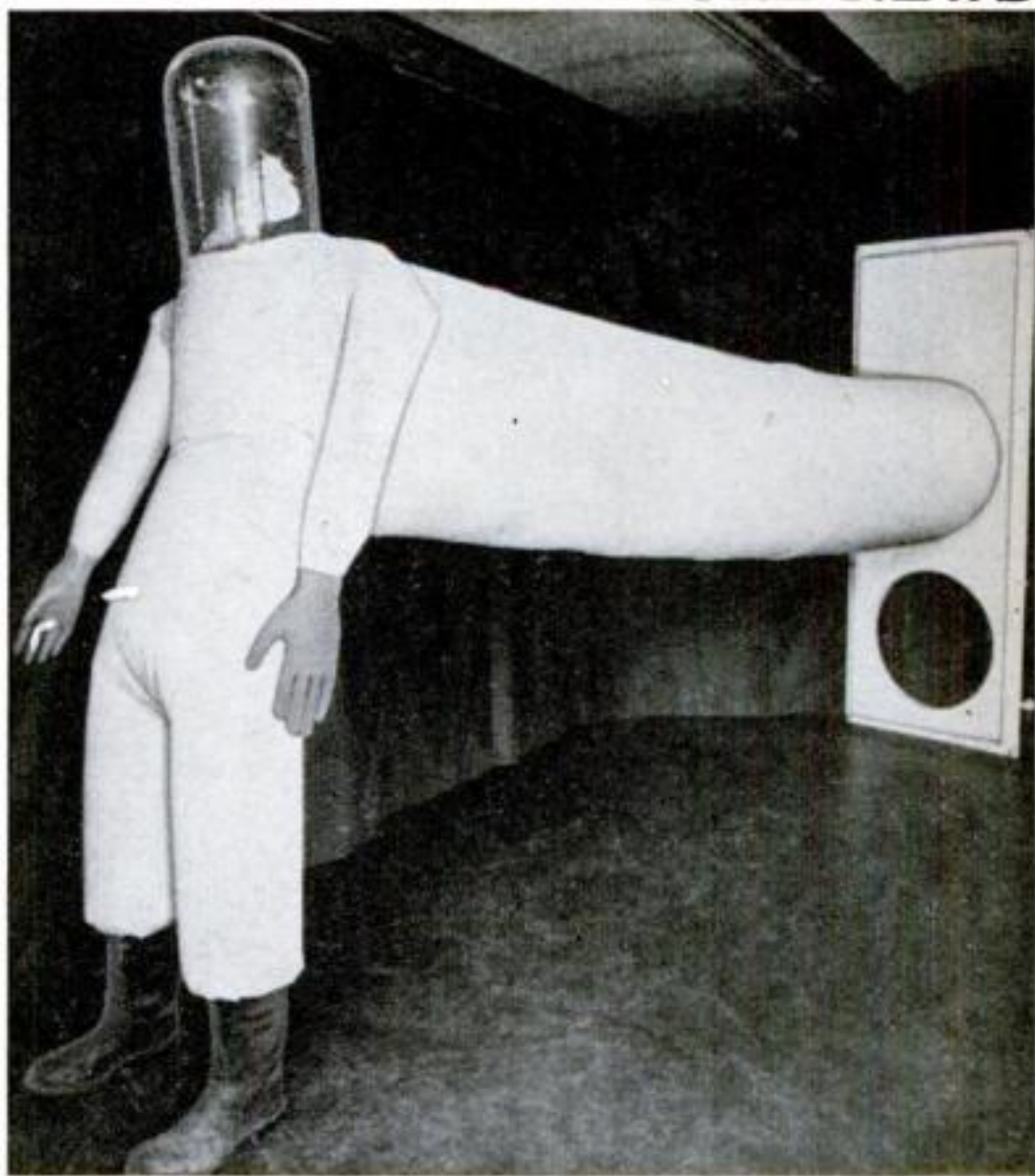
Flowerpots on the parking meters should make Erie, Pa., motorists drop their coins in the slots with a right good will. The pots, held in place by decorative iron scrollwork, add a touch of color to the city, and may even take some of the curse off the doleful business of renting parking space on the street.



Double-decker Dodge

A panoramic view and seating and sleeping room for three are features of the homemade upper deck of this '56 Dodge.

Owner John Swanberg of Minneapolis (shown leaning on the fender above) built the extra deck in his spare time for \$1,000.



For well-dressed scientists

The only way to put on the coveralls above is to crawl into them feet first through the tunnel at the back. British scientists get in that way to do their work in sealed radioactive rooms.

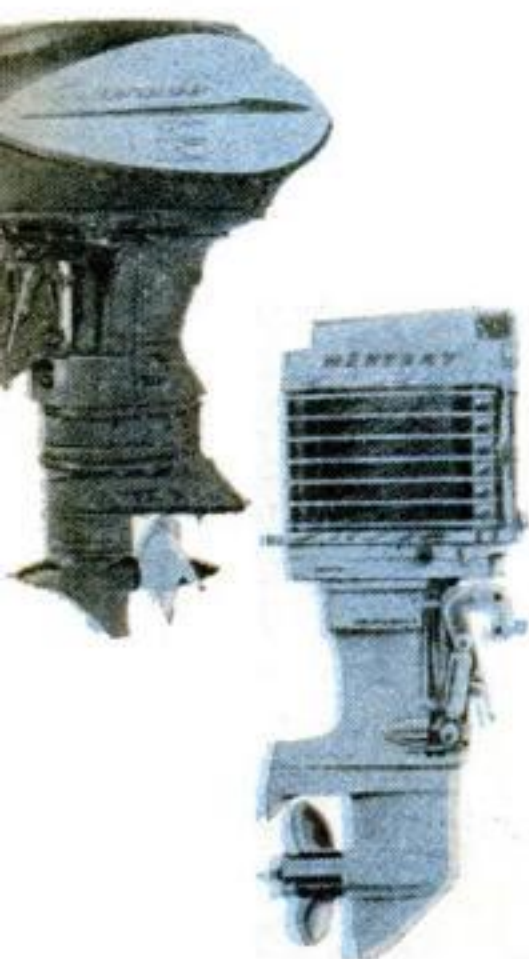


Restoring view at Niagara

The observation tower shown under construction here is being completed on the American side at famous Niagara Falls. It replaces Prospect Point, a favorite tourist attraction for more than a century until it collapsed in a rock slide in 1954.

What's Coming

Today...



Big motors now are reliable, but also both heavy and fuel thirsty.

By Hank Wieand Bowman

NO GREAT excitement surrounded the unveiling of 1961 outboard motors. A maximum-horsepower plateau, well under the 100-hp. mark, has been temporarily reached. There are refinements: more sound dampening, a trend toward fixed carburetor jets and larger alternators, more use of thermostatically controlled cooling, new contouring of lower units, and increased application of shock absorbers on tilt mechanisms.

Nearly all outboard manufacturers claim "improved fuel economy." But fuel thirst is still an Achilles heel of their power plants.

In general, 1961 can be looked on as a year of refinement and restyling of existing models. Yet the outboard manufacturers can't afford to repeat this retreading process in 1962. Rumors fly inside the business of exciting developments in the offing—everything from supercharging and fuel injection to blue-sky dreams of free-piston and turbine power plants. By 1965 you can expect radically changed detachable motors.

It is this word "detachable" that governs the future of the outboard. Since boat designs are not expected to change materially, and since the outboard manufacturer must protect his market against further encroachment by inboard engines, particularly by the new *outdrives* (inboard engines with outboard units), you may expect the outboard to continue in its present basic format, which offers advantages over competing power packages.



Hank Wieand Bowman, America's most famous boating writer, has almost lived afloat for the last three decades. A skipper of a PT boat in the South Pacific and the English Channel during World War II, and a commander in the Navy in the Korean War, Bowman now travels some 40,000 miles a year to try out new motors, boats, and waters. The author of 12 books and more than 1,000 magazine articles on technical aspects of boating, he also finds time to write "Water Line," a nationally syndicated newspaper column.

This article, a prediction of what's coming in outboard engineering in the next few years, is the first of a series that Hank Bowman will write for POPULAR SCIENCE.

in Outboard Motors

The outboard's virtues. By this I mean that the outboard motor will continue to be built with detachable, clamp-on securings so that an owner may transfer it from boat to boat with a minimum of effort. It will continue to feature a tiltable drive unit, so that outboards may be operated in shallow water or beached at will. The power head will be retained in its present location—outboard of the hull proper—to take advantage of the safety factor afforded by this location: freedom from bilge fumes and the threat of explosion, and freedom from the mess and hazard of fuel accumulation in cockpits and bilges.

The outboard's location, coupled with well-designed shock-sound-dampening, and vibration-isolation mountings, plus an underwater exhaust system, makes it quieter now than all but the most exceptional inboard or outdrive installations. Yet the outboard manufacturer is faced with two basic problems: higher fuel costs due to the greater fuel consumption of the two-cycle versus four-cycle design, and the approaching upper limits of weight and size, which seem to preclude any great horsepower advance without loss of the detachable advantages. Both drawbacks will be overcome within the next few years.

What won't happen. Don't expect, however, a swing to either four-cycle or diesel designs as solutions to the fuel-consumption problem. Discount the four-cycle because of the weight factor, as well as the greater adaptability of two-cycle design to constant high-speed operation. Four-cycle marine engines (without reverse gear, prop shaft, struts,

Tomorrow?

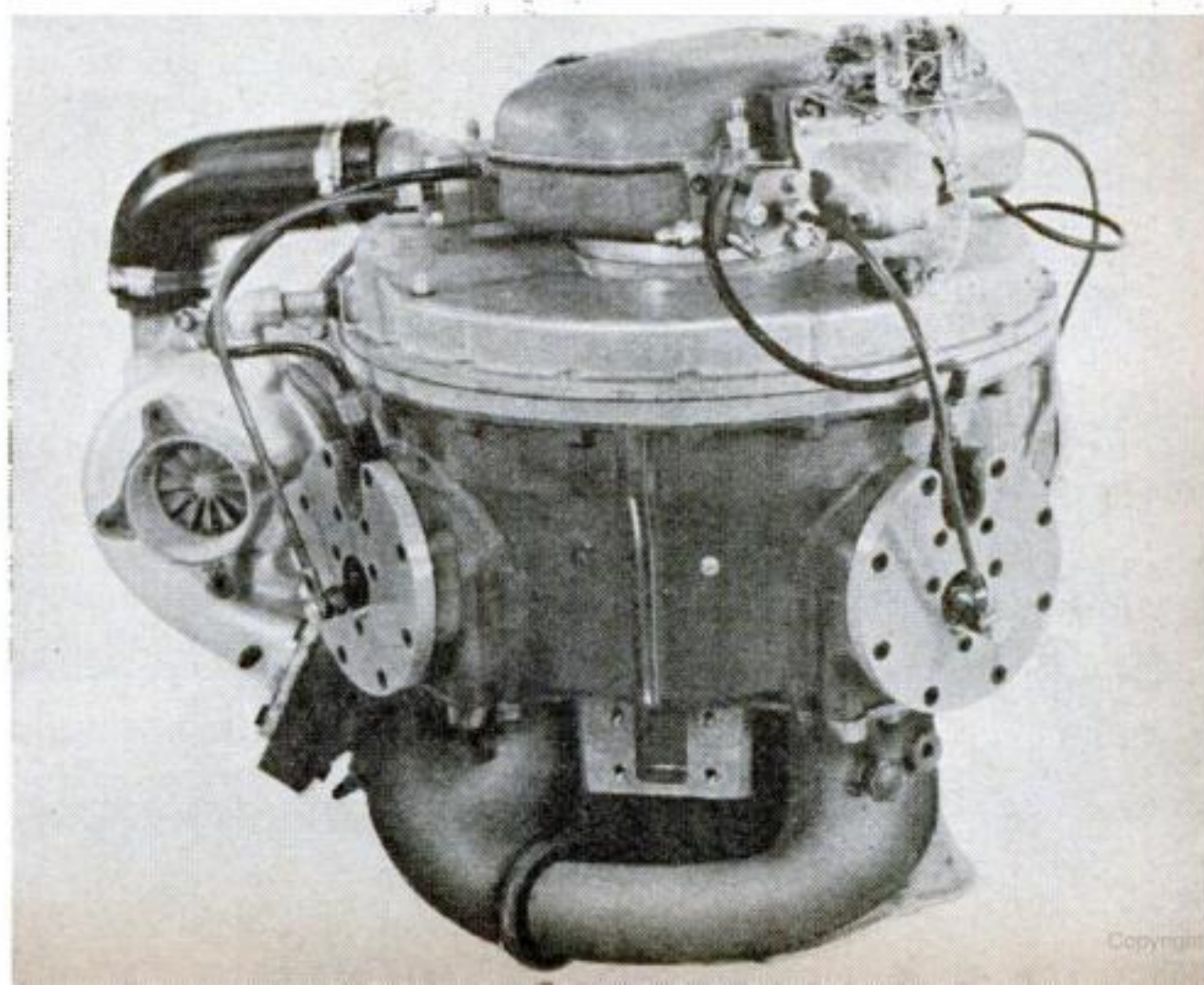


One nonproduction model has many design features now in the offing.

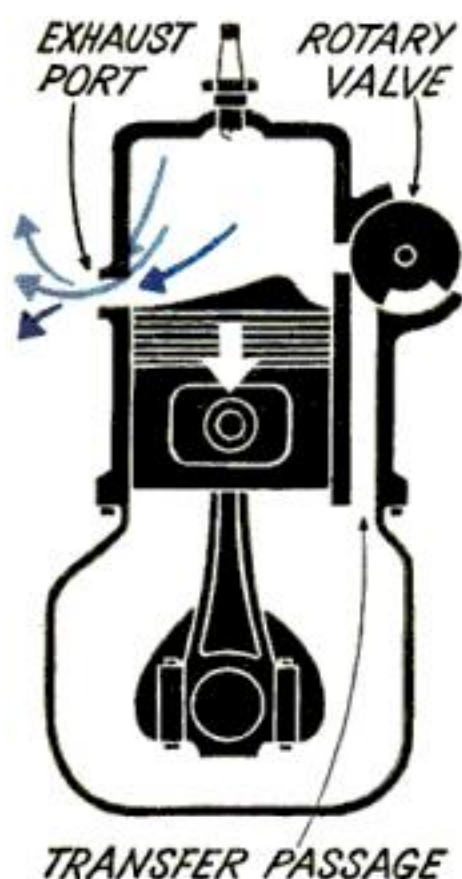
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This is the power head of the experimental Scott engine shown above at right. It is a four-cylinder radial.

Displacement is 90 cu. in.; output is 125 hp.; and fuel consumption is .55 lb. per hp.-hour. The turbosupercharger adds 15 hp. at full throttle. Engine has oil pump and sump, wouldn't need a mix of oil and gas.



Rotary valve could improve port timing



With a rotary valve added to the transfer passage, there would be a longer "blow-down" time for exhaust scavenging, and no loss of the fresh charge out the exhaust. This would be a fairly simple way to improve two-cycle efficiency.

rudder, and propeller) have a specific weight of about 4 to 4.5 lb. per horsepower. Though the broader use of aluminum alloys to replace cast iron will unquestionably trim this somewhat, the largest outboard two-cycles currently have a specific weight of about 2 to 2.5 lb. per horsepower. By 1965 the weight-to-horsepower ratio of the outboard will be even more favorable.

Remember that the outboard manufacturer wants to keep his power plant detachable. So he isn't about to give up the weight-to-power advantage offered by the two-cycle design. This consideration would also eliminate the diesel, even if its far greater cost per horsepower weren't a factor.

Granted, diesel outboard motors are already being produced. But pleasure-boat versions are available only in small sizes (10 hp. and under). In this modest power range the diesel outboard has a limited specialty application, where its high initial cost and weight, plus inherently rough operation, are no deterrents. To view the present low-power diesel outboard as economical is about as practical as looking on a cigarette lighter designed to burn diesel fuel as a real dollar saver. Only in far higher-power versions would the fuel economy of an outboard diesel overcome its disadvantages. Excessive weight in the larger versions currently rules it out for small pleasure craft.

The distant gas turbine. One manufacturer recently announced a contract to design a 125-hp. outboard gas-turbine engine for the U. S. Navy. The power unit will employ a heat exchanger so that normally wasted exhaust heat will be reintroduced into the engine to provide more efficient use of the fuel. Delivery is scheduled for 1962. Including the drive unit, it is expected to weigh two pounds per horsepower. But will it be available to the pleasure-boating public? Perhaps in the distant future; certainly not within the next five years.

For one reason, listen to Dr. Gordon Millar, a gas-turbine expert formerly employed by Ford and now assistant chief engineer for the McCulloch Corporation: "Pleasure-boat outboard motors as we recognize them today will not go to gas turbines in the near future since they cannot be produced competitively with die-cast engines."

In reasonable quantities the lowest production cost of gas turbines of single-spool design would be about \$15 per horsepower. This would mean that an 80-hp. gas-turbine outboard would today cost its manufacturer about \$1,200 a unit, or around \$2,000 by the time it reached the consumer. Fuel consumption of the single-spool design would be no better than a pound per horsepower-hour. In larger sizes, incorporating the more costly heat generator, fuel consumption would be about .6 or .65 lb. per horsepower-hour. Though turbines may ultimately replace reciprocating engines, a major breakthrough to bring the costs down will have to come first.

Gyro effects. Engineering problems would arise in applying the gas turbine to small craft. One is the gyro action created by the rapidly revolving turbine rotors (in the neighborhood of 40,000 r.p.m.), which would cause steering problems. Another is the relatively narrow operating range, though segmented nozzles may some day give the gas turbine

the wide speed range that is required by pleasure boats.

Early application of atomic power to the outboard certainly will not come within the next decade. Space and weight requirements for shielding make it improbable.

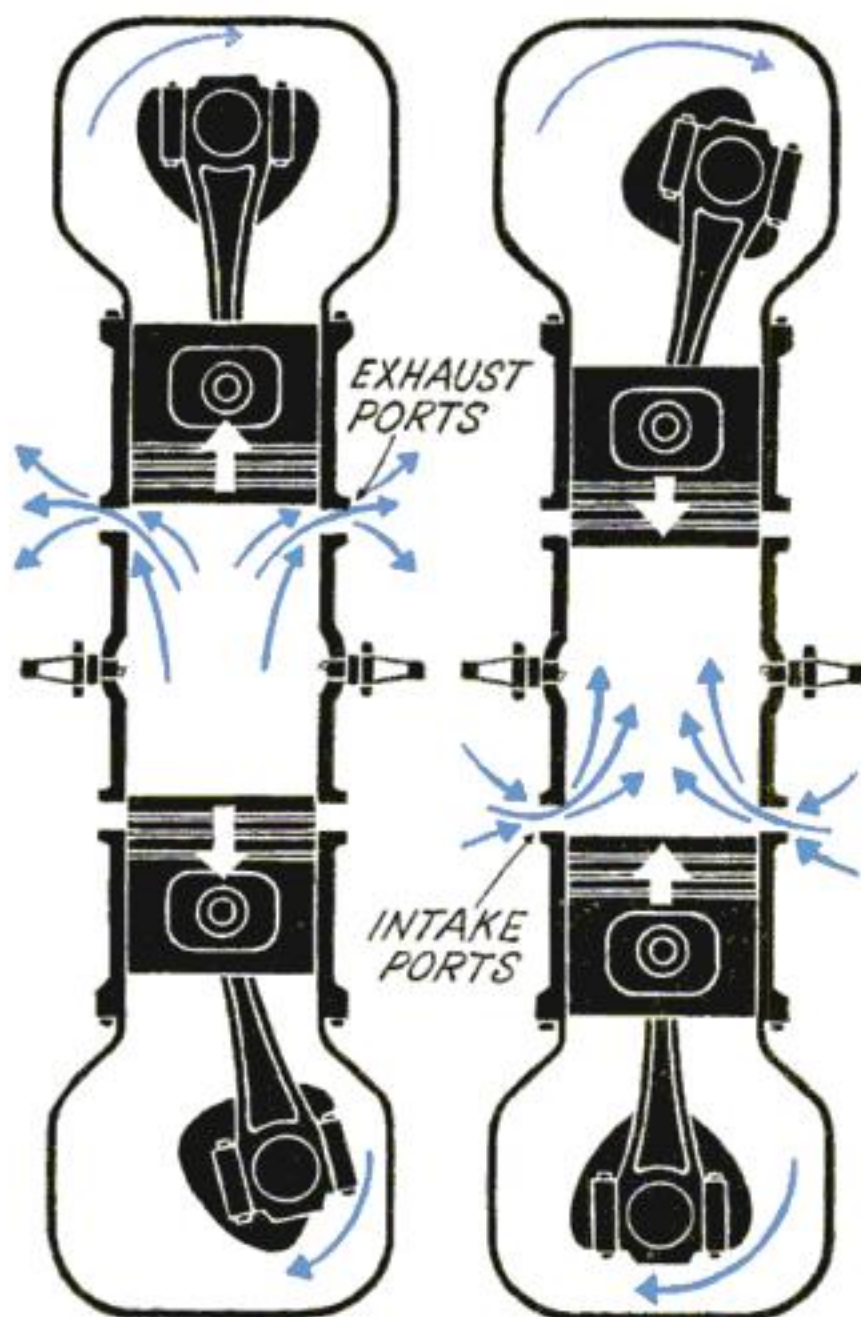
The free-piston engine, a hybrid that develops no direct mechanical power but delivers exhaust gas under high pressure, could be used to run a turbine. It has the advantage of extreme light weight, since it has no crankshaft, connecting rods, or flywheel. But too many engineering problems remain to be overcome for it to be packaged for the consumer even by 1965.

In five years: If you talk informally to engineers at Evinrude, Mercury, and Scott, you'll find basic agreement on the future. Power will probably not exceed 125 horsepower. Marketable motors will still be prop-driven. Two-cycle engines will still be used, but will be inherently balanced, eliminating most vibration and shock dampeners. Horsepower-to-weight ratios will be further improved, and fuel consumption may drop below .5 lb. per horsepower-hour. Although the two-cycle engine is already impressive on the basis of horsepower per cubic inch (the present Merc. 500, for example, develops 50 hp. from 44 cu. in.), more efficient designs will make possible outboard engines developing two and three hp. per cubic inch within the next few years. Further refinements of specially designed two-cycle lubricants will cut current oil costs nearly in half. This year McCulloch will market an outboard oil engineered for a gas-to-oil ratio of 40:1. This and other new outboard oils (Ashland and R.P.M. are two) will cut oil expenditures to under two cents per gallon of fuel mixture.

Dream jobs. Just as automobile companies have built radical vehicles—both to explore new designs and to win publicity—the outboard industry will display a rash of experimental engines. The first few will appear in 1962. These will unquestionably include gas turbines, free-piston engines, water-jet, and even air-jet propulsion. Some will be mere drawing-board conceptions, others dummy mock-up designs for publicity, and a few will be experimental working models. Manufacturing costs and engineering bugs will keep most of these Jules Verne deals out of the consumer's hands.

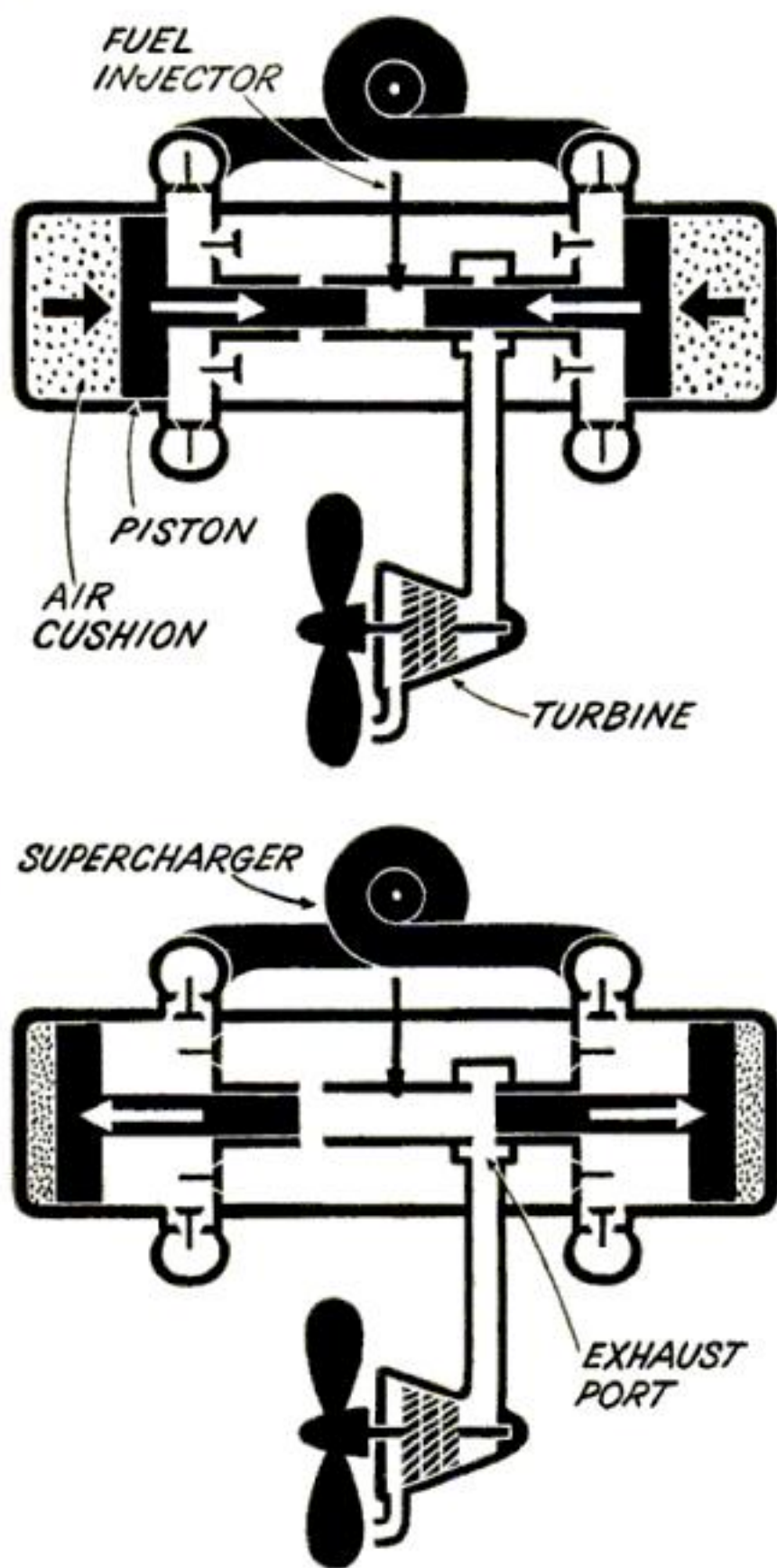
The two most striking features that will actually be incorporated in large outboards by 1965 are fuel injection and superchargers. Internally the main design change will be a shift from symmetrical to unsymmetrical timing to improve breathing. Present outboard motors use symmetrical timing. With this design the exhaust port is opened before the fuel intake or transfer port, and the exhaust port closes after the intake port. Since the exhaust ports open sooner and close later than the intake ports, some of the fresh fuel charge

**"Uniflow" design
might save fuel**



A two-crankshaft design, with the pistons tied in fixed relationship by gears, would permit longer, more efficient scavenging of the burned gases—yet without wasting any of the fresh incoming mix out the exhaust. But the extra weight and cost would be big penalties.

**Free-piston outboards
may come—but
not soon**



A free-piston engine is a fine producer of hot gases to drive a turbine. Its power and potential efficiency might make it a fine outboard. But many engineering and cost obstacles would have to be overcome first.

escapes out the exhaust ports. This increases fuel consumption and decreases thermal efficiency.

Crankcase a poor pump. Another limiting design feature of current outboards, one which also contributes to inefficient scavenging, is the use of the crankcase as a precompression chamber. The pumping capacity of the outboard crankcase is too limited, and its scavenging efficiency too low, to be tolerated in the search for more power from a lighter, more economical engine.

Unsymmetrically timed two-cycle engines will make their appearance. Superchargers, far more efficient than crankcase precompression for both fuel-vapor pumping and exhaust scavenging, cannot be applied efficiently to engines with symmetrical port timing; but they work fine with unsymmetrical port timing.

Two-cycle engineering designs have long existed that will provide efficient substitutes for the cross scavenging of symmetrically timed engines. One choice open is the use of a rotary valve between the transfer passage and the inlet port. This allows a lengthier blowdown or exhaust-scavenging period, and at the same time allows fuel to be transferred from crankcase to cylinder after the exhaust port has been closed.

Another unsymmetrically timed version is the "uniflow" design. This is a double-piston layout that uses two crankshafts—one at either end of the cylinders—connected by a gear train. One piston controls the exhaust ports, the other the intake ports. The scavenging period can be double or triple that of a cross-scavenged single-piston design. Both intake and exhaust ports can be enlarged since each can occupy the same relative amount of space that both do on cross-scavenged designs.

Good-bye carbs. Regardless of which unsymmetrically timed design is chosen, fuel injection replacing conventional carburetion is a certainty, for injection mates with two-cycle designs like a knob with a door. The deterrent to date has been cost. According to Lowell Haas, Scott's chief engineer, fuel injectors will within five years cost only from \$3 to \$5 more per cylinder than conventional carburetion, making their use practical.

Greater volumetric efficiency will be obtained because metering between cylinders will be more perfect and the combustion chamber can be more thoroughly scavenged (since air rather than a fuel-air vapor mixture will be used for scavenging). Haas and his engineers already have a working four-cylinder radial outboard fitted with fuel in-

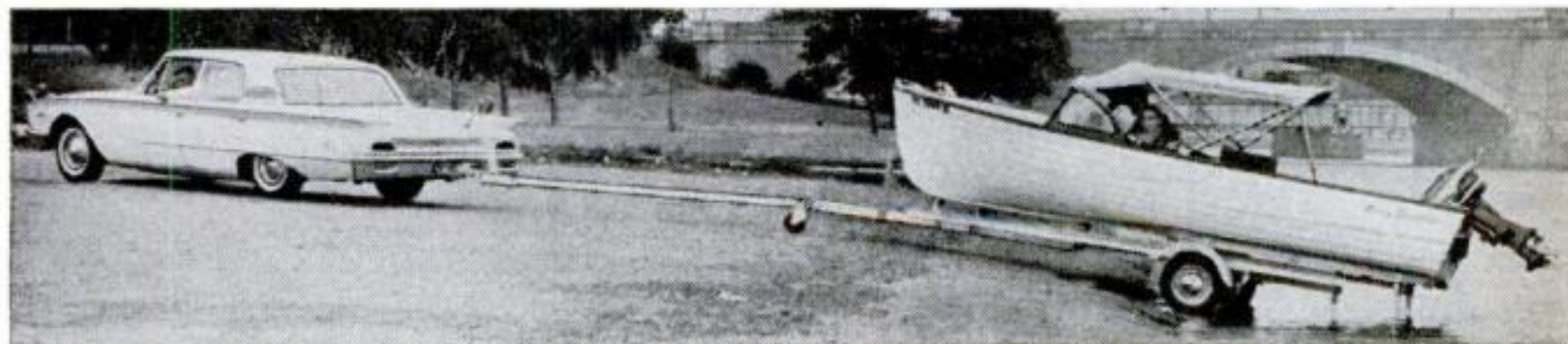
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What's New Afloat

Outboard Skimmers. The Skip-Jack at top right will do 40 m.p.h. with a 25-hp. motor. It has a four-by-eight-foot fiberglass hull eight inches thick at stern, tapering to two inches at bow. The power skis below it are two styrofoam-filled fiberglass pontoons held rigidly together. An 18-hp. engine will propel them at speeds up to 24 m.p.h. Without motor: Skip-Jack, \$395. Hinkle Contracting Corp., Paris, Ky. Power skis, \$475. Jack Drury, Gill Hotels, P. O. Box 4037, Ft. Lauderdale, Fla.



Quick-Release Shoes. Even when tightly laced, these boating shoes can be loosened instantly in a man-overboard emergency. Four snaps secure each laced flap; one pull and the shoe slips off easily. Nonslip felt soles give sure footing on slippery decks. Price is under \$10. International Shoe Co., St. Louis, Mo.



Boat-Launching Trailer. The heaviest boat can be launched and retrieved automatically by this extending-boom trailer. When towed by a car, the trailer is of conventional length. At launching site, boom slides out and eases boat into water. Smallest size (top photo): \$184. Noramgrex, Malden, Mass.



What's New Afloat continued

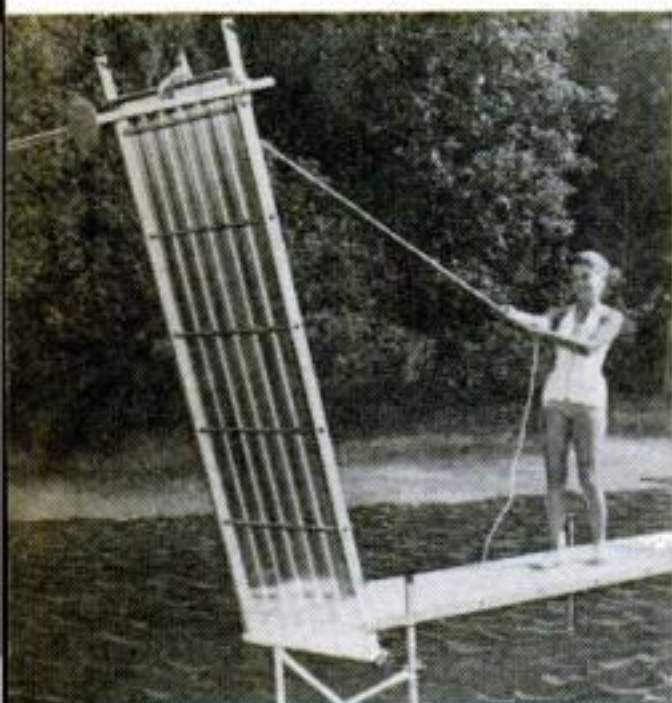
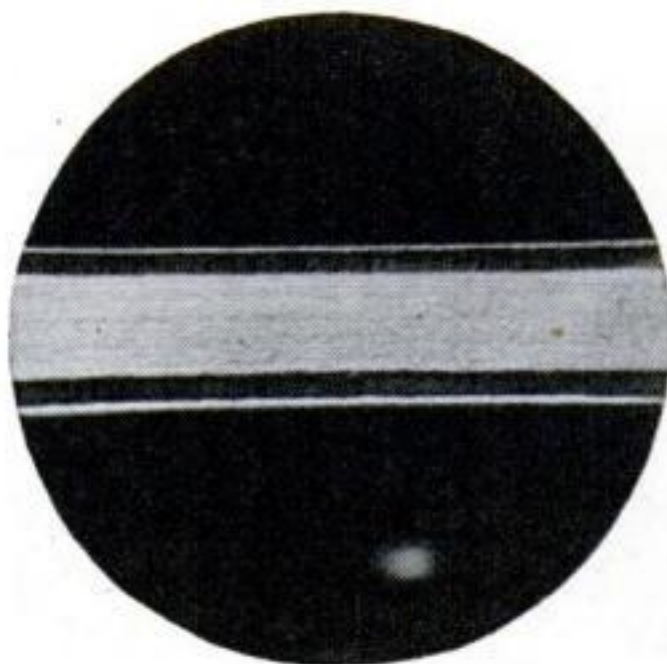


Portable Sailboat. Convenient car-top transportation is offered by the under-50-pound Sea Snark. The 11-foot-long, 38-inch-wide hull is made of lightweight

Koppers polystyrene; the 45-square-foot sail is polyethylene film; and mast, spar, and boom are aluminum. About \$100. Snark Products, 40 W. 57th St., NYC.



Sandwich Hull. A five-ply laminate with foam-plastic-rubber core, hard plastic-rubber sides, and a weather-resistant rubber skin is being used to make strong boat hulls with built-in flotation and insulation. It's manufactured by U. S. Rubber Co. for the Thompson (photo at left), Custom Craft, Carter Craft, and Connecticut boat lines.



Aluminum Pier. This prefabricated dock comes in eight-foot sections for easy out-of-water assembly. Each section with standards weighs only 45 pounds. It won't sink into soft bottoms, and will withstand gale-force wind and waves. Sections cost \$74 and up. Alumidock, Randolph, N. Y.



Sail Motorboat. The hinged mast on this sailboat tilts for low bridges or comes down entirely within 15 minutes to convert the craft to an outboard-powered cabin cruiser. The unsinkable 17-foot hull is of molded fiber-glass. Total sail area is 180 square feet. Picnic 17 sells for \$1,985. General Boats, NYC.



Luminous Paddle. Emergency paddle also serves as a distress signal. Finished in fluorescent paint, it is visible for more than 1,500 feet on a clear day when waved to and fro. It has been adopted by many outboard clubs. Wait Mfg. & Sales Co., 415 N. Elwood, Tulsa, Okla., markets it for \$1.

BOATING

1961



New Hinged Boat Folds Flat

From stem to stern, the keel's a sealed piano hinge. When the day's fun is over, the hull collapses. Here's how to build it

By Alfred W. Lees

PS PHOTOS BY W. W. MORRIS

EVER see a piano hinge turn a corner? The one incorporated into this remarkable boat does more than that. It forms a broad U, running continuously down the bow, along the keel, and up the stern of the canoe-like hull.

By introducing the hinge principle into boat construction, you're able to collapse ribless, lightweight aluminum hulls for easy portage. You can slip your flattened boat into a station wagon and still have plenty of room for

KEEL HINGE, pulled apart for clarity, shows how aluminum sides are joined by brass pin driven down each bow to interlock the barrels. Gunwales pivot on channel brackets to expand hull.

CONTINUED

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From wheels to water: Launching is a five-minute, one-man job



1. AT ROAD'S END, one trip is all that's needed to move both lightweight units to the shore. Holes in deck serve as handgrips. Knee pressure

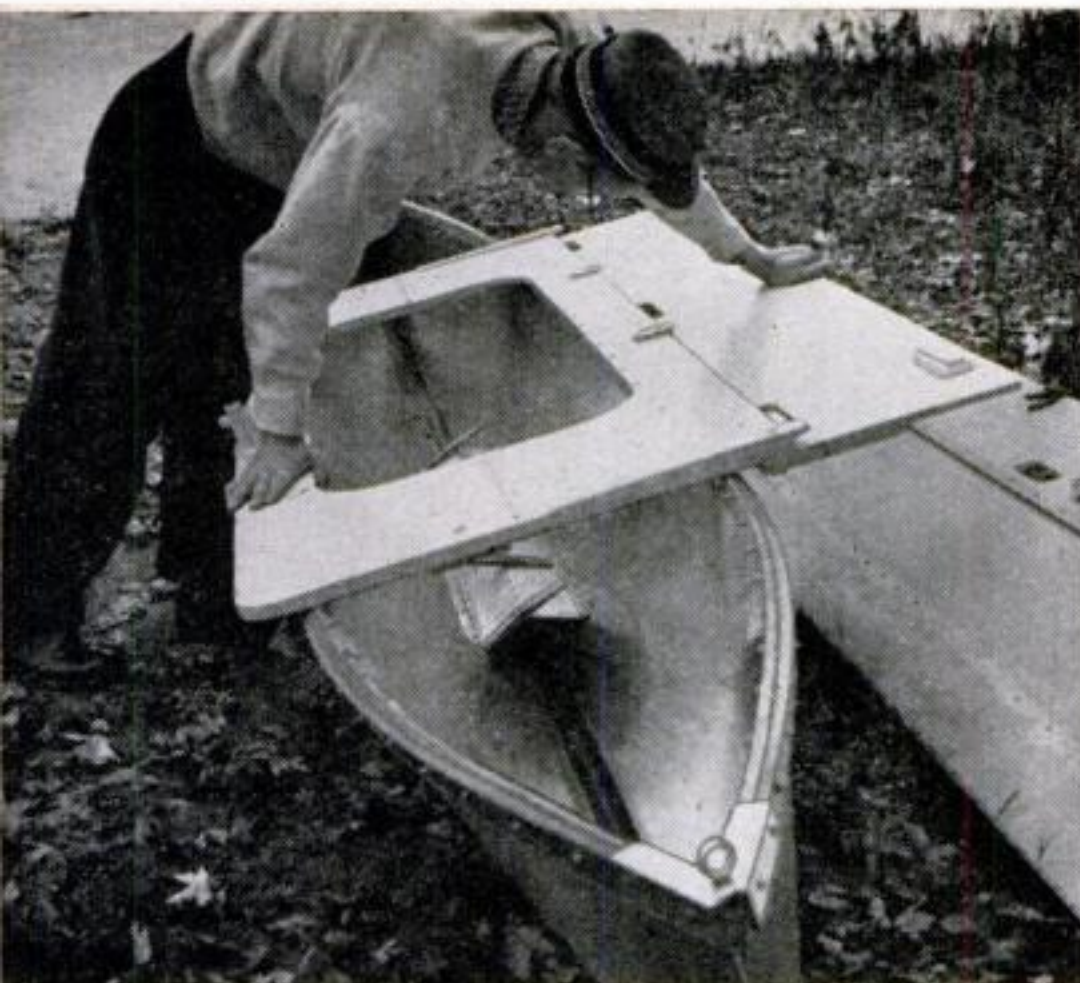
and a quarter turn of the oarlock unlatches each half. The folded deck, hinged to both inwales, acts as a pry to spread the hull.



DESTINATION: ADVENTURE. And getting there is twice the fun with outboard power. Here

Darby is steering a 1½-hp. motor. Another photo farther on shows the boat under sail.

15 pivoting catches keep deck as sturdy as if it were one piece



2. WHEN DECK IS OPENED, buttons underneath are turned to catch steel bars projecting across hinged joint at each end. A push flattens the



cleated floor. After deck overlaps are joined, spanners attached at each end increase rigidity and provide motor mount and sail socket.

bulky camping supplies. Or lash the hulls to the top of your sedan and forget about a boat trailer.

Where do you buy a curved piano hinge? You don't. The edges of the hull's flat aluminum sides are crenelated and curled (with a homemade jig) to form their own hinge. The effect is similar to lacing your fingers together and pivoting your palms open and shut. How can a curved hinge work? The clue to its operation is that it opens least at the curved points. There's enough play between the barrel sections to permit this limited pivot as the gunwales arc apart and the aluminum sides become concave.

But can it be made watertight? Easily, with modern materials. Epoxy-resin cement bonds fiber-glass tape across the hinge, and latex seals against leaks.

Although the ingenious collapsible feature is valuable in a canoe, its worth is more than doubled when applied to a catamaran. The chief disadvantage of these twin-hulled boats is their clumsy bulk out of the water. They take up to three times the storage space of a conventional boat and are awkward to transport.

To overcome both objections, Newman Darby of West Pittston, Pa., developed the hinged version shown here. As the hulls are collapsed, the attached floors

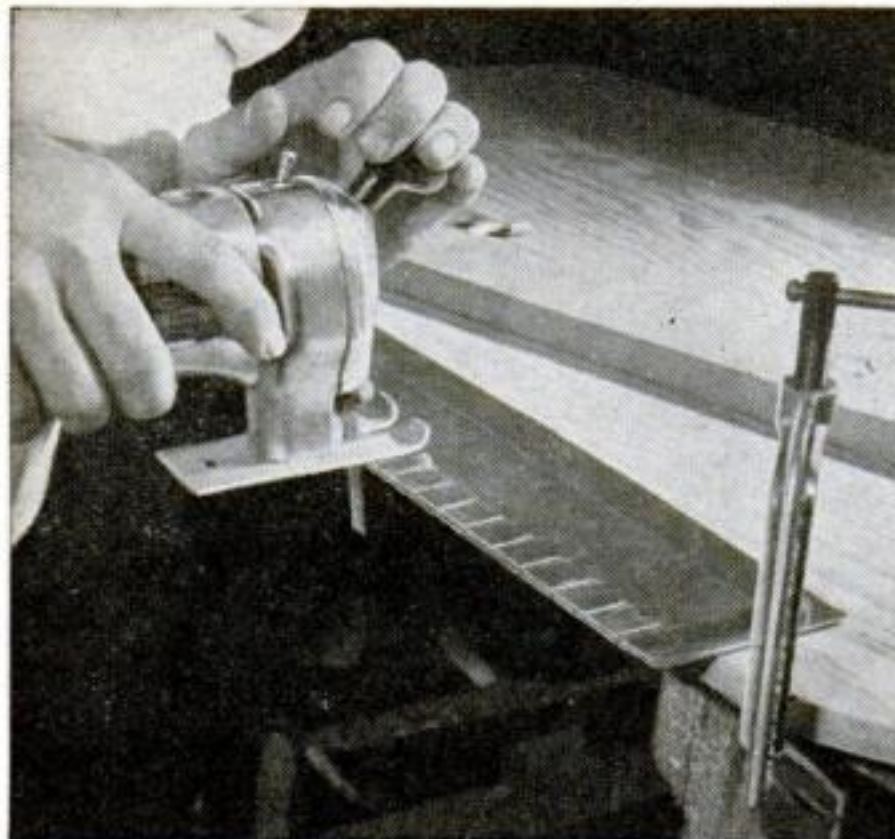


3. SHOVE OFF AND YOU'RE UNDER WAY. The oar horns slip into the top of the projecting locks for comfortable one-man or two-man rowing.

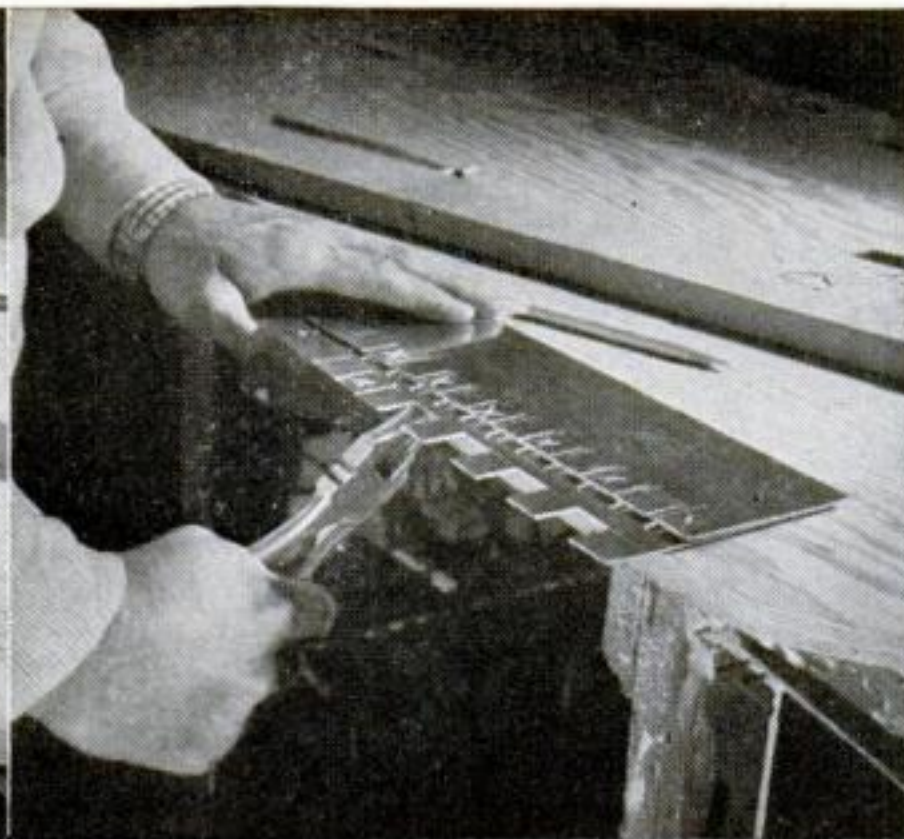
and overlapping plywood decks also fold, converting the catamaran into two 5"-thick units weighing less than 70 pounds apiece. These units can be stored along the wall of the garage, ready to load in (or on) your car. When the launching site is reached, one man can trot them both down to the shore, and assemble them into a craft that can be propelled with oars, a sail, or a small outboard.

Materials for this 12' catamaran should run about \$75. The large .051" aluminum

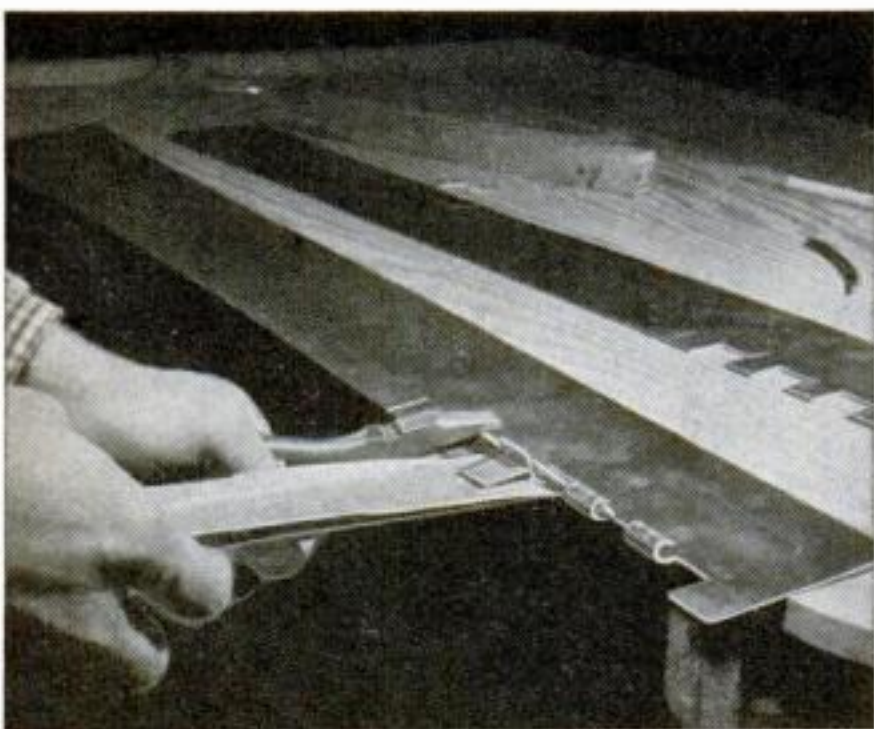
How to make the keel, floor, and deck hinges



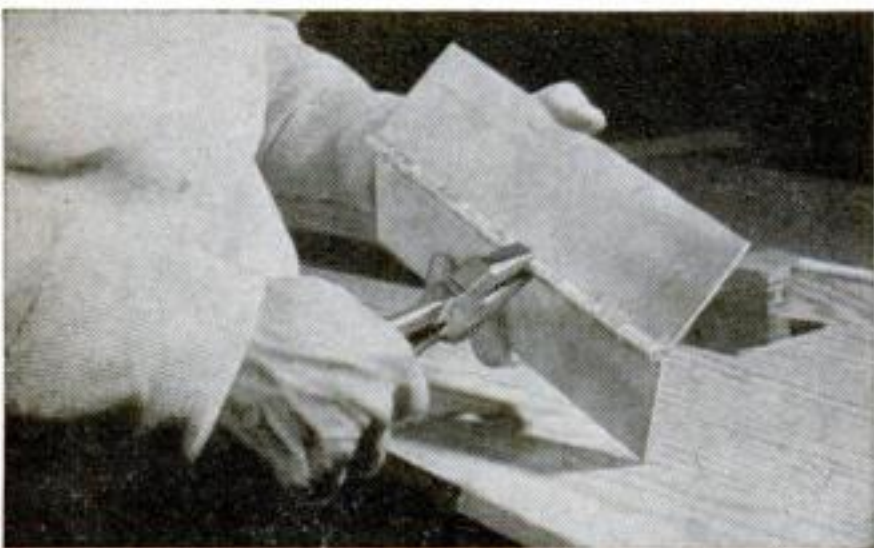
BARREL TABS ARE CUT on several pieces at once with a saber saw. Stack the blanks and apply C clamps. Lay out tab widths with jig. Scribe length-line with sharp-pointed marking gauge.



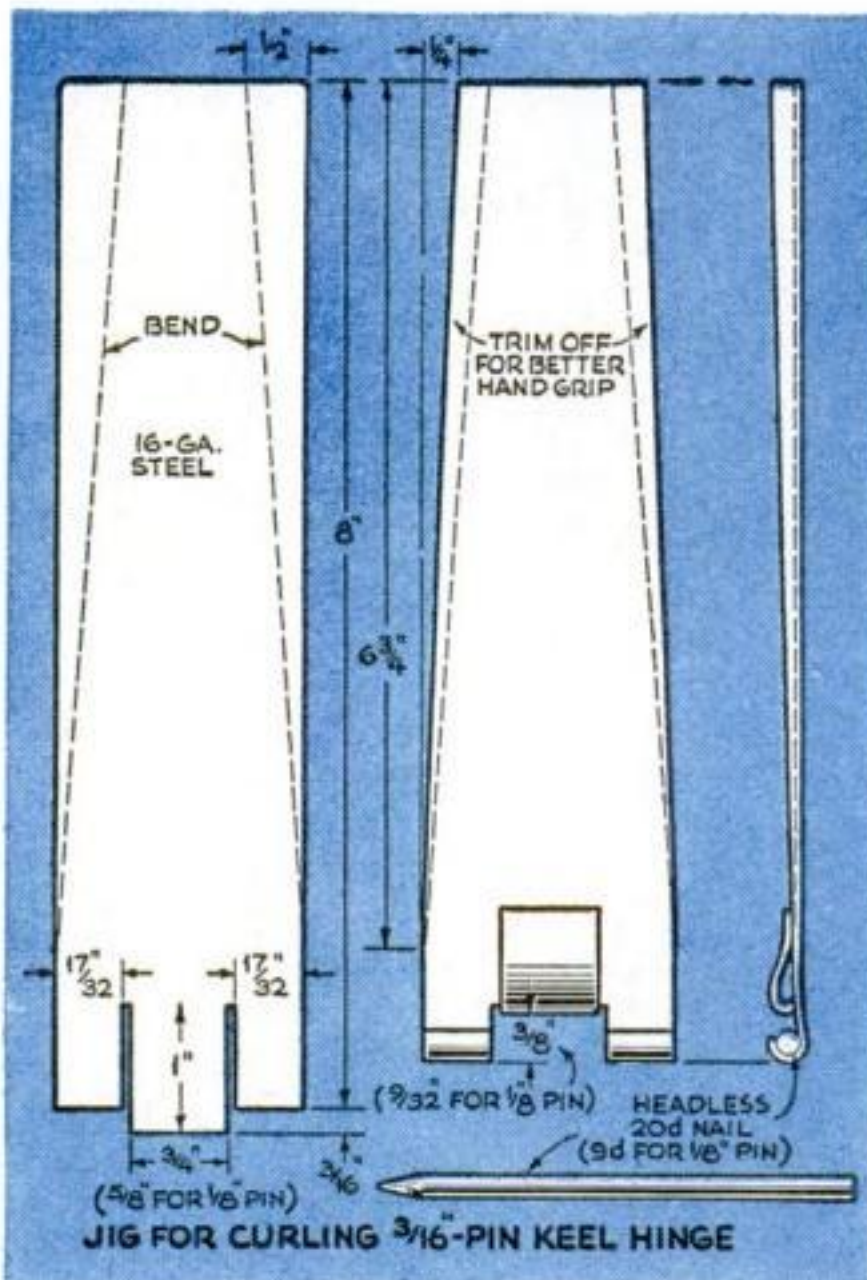
UP-AND-DOWN pliers twist breaks out alternate sections. Note that these are marked for removal on matching pieces to prevent error. Lay jig's pin along line, bridging two gaps.



HOOK JIG UNDER PIN and bend one tab up and over until jig rests on face of work. One end of pin is inserted in previously curled tab; pliers hold other end. End tabs are tricky.



CRIMP BARREL SECTIONS SNUG after joining both leaves with hinge pin. Saw kerfs give enough play—even on curved keel sections. For these, use bent jig pin seen in photo above.



JIG FOR CURLING HINGES must be made in two sizes. Size shown is for the $\frac{3}{16}$ "-pin keel hinge. Jig for the $\frac{1}{8}$ "-pin floor and deck hinges is identical except for dimensions noted.

COMPLETE PLANS AND DETAILS for constructing the catamaran appear at right. Side and end views are given for both open and folded positions to indicate how hulls change shape.

sheets can be secured from distributors listed in any classified directory. Specify an alloy in the 5,000 series, of half-hard temper. Or you may be able to buy H-12 building sheets at a sheet-metal house.

This boat was born to adventure. Darby built the high-riding craft for field trips into remote shallows of the Susquehanna River. His search for Indian relics requires a good deal of portage, and light, fold-up hulls were the answer.

Perhaps your boating needs are simpler. But if it's fun you're after, a catamaran will double it. As a party boat, it welcomes aboard four at a time, for face-to-face conversation. As a diving raft, it's virtually capsiz-proof.

Snipping the hulls. You can make the entire boat. Just snip all four hull sides from two 4'-by-12' aluminum sheets. Leave an extra $\frac{3}{4}$ " along the stem, stern, and keel line for the hinge barrel. The blanks can be stacked so that all barrel tabs can be cut at one time. The straight top edge of each blank is



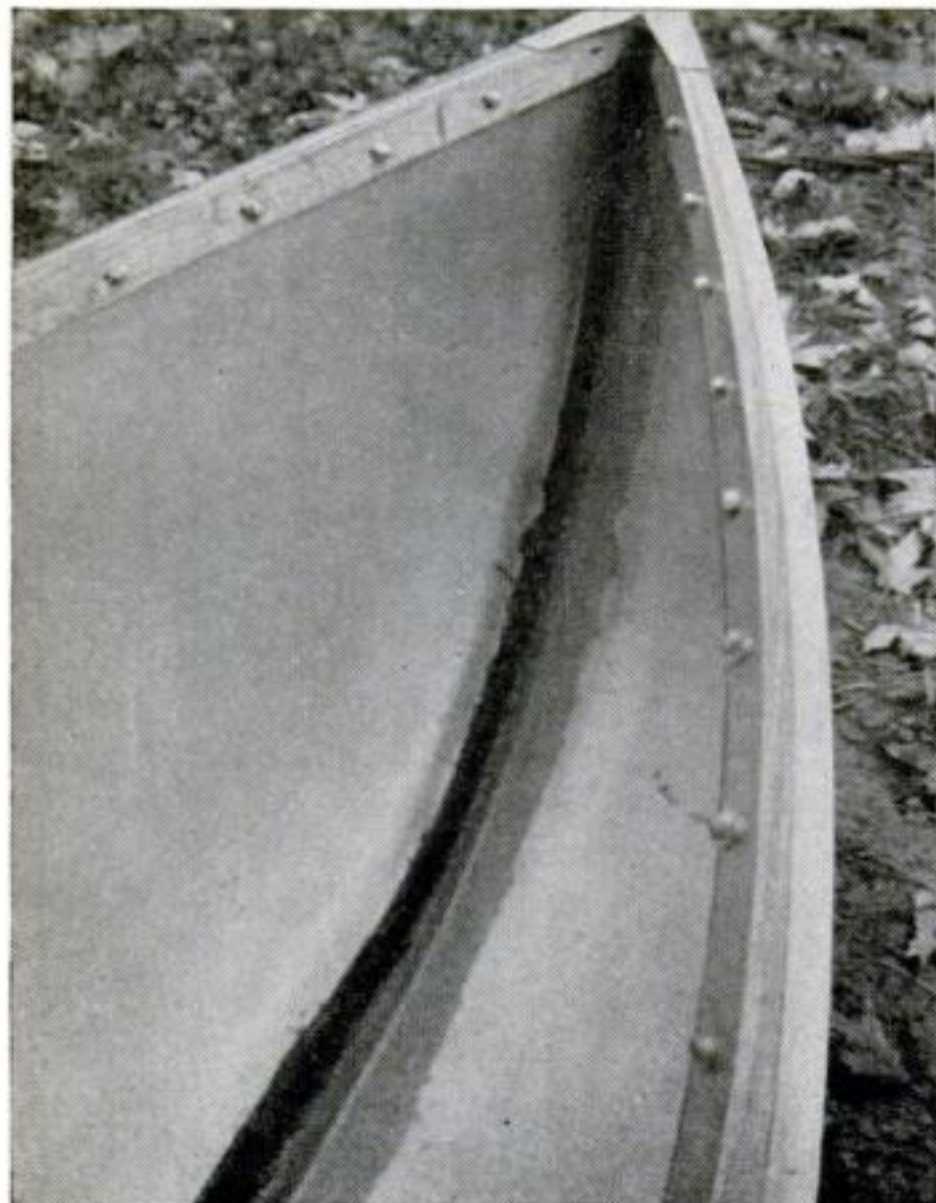
sandwiched between two $\frac{3}{8}$ "-by-1 $\frac{1}{4}$ " oak strips and fastened with bolts every 3 $\frac{1}{2}$ ". The bolts along the identical fore and aft bows must pass through slots that permit side play, because the gunwale curves

during the spreading of the hull (see detail). The section amidships, where the deck is hinged to the in-wales, may be snugly bolted through $\frac{9}{64}$ " holes.

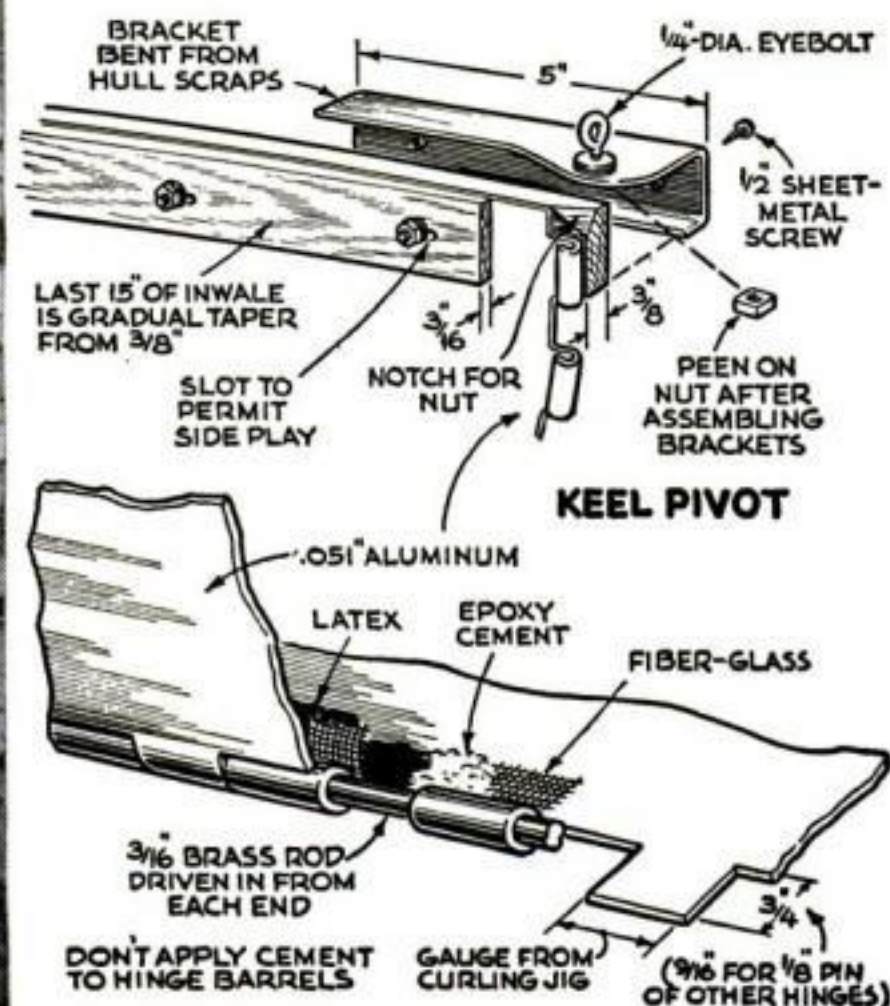
The pivoting gunwale brackets are put in place temporarily so that the eyebolt hole can be drilled right over the end of the brass hinge pin. Remove the brackets, fasten the eyebolt through the lapped top flanges, and screw the brackets to the gunwales.

The four hinges needed for each folding deck may be purchased, or you can make them with the smaller curling jig. This jig is also used to curl barrels on both edges of the two floor leaves required for each hull. Assemble these units to leaves riveted to the inside of the hull. The rivets must be sealed with spar varnish or epoxy.

How can a hinged keel be watertight? The answer's inside



A SEALED JOINT DOES IT: After pin is driven in from each end and the pivoting gunwale brackets are attached, tape is bonded across the hinge and covered with five coats of latex.





Boat Buoyancy Now Comes in Cans

Like dumping cake batter into a pan—you just pour the chemical foam into all the nooks and crannies

By V. Lee Oertle



YOU can now sinkproof a boat with two cans of chemicals. Stir the contents together, pour the liquid into empty spaces in the hull, and—presto!—it foams up and fills every nook and cranny with a plastic foam of great buoyancy.

The plastic foam is the same familiar white, cellular stuff you've seen in solid blocks. The new liquid form was developed after years of struggling to fit the blocks into small, odd-shaped, inaccessible spaces. Now even the tiniest and most awkward spots are easy to fill.

The liquid begins to foam up almost

immediately when it's poured in, expanding to 35 times its original volume. Each cubic foot of the foam weighs only two pounds, yet will support 60 pounds of extra weight when it's submerged.

The foam-in-place plastic also adds tremendous strength to a hull. It bonds itself to the inside, forming a tough, reinforcing backbone that can withstand pounding that would un-seam an ordinary hull. The millions of tiny cells in the foam are filled with gas and sealed closed so no water can seep in even if the plastic is gashed or punctured.

The liquid plastic is sold packed in

CONTINUED

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Test setup shows how the foam swells 35 times



MIX A FEW DROPS of the two chemicals in a pie tin for a dramatic demonstration.



IN 10 SECONDS, the gas-filled plastic swells and begins to overflow the pan.



THREE MINUTES LATER, the foam has expanded into the buoyant ball seen above.

kits containing equal parts of the two chemicals needed. One brand, Safety Foam, costs about \$35 for a two-gallon kit—enough for 12 cubic feet of expanded foam. A two-quart kit, producing three cubic feet of foam, is about \$11. Prices go down as the quantity you buy goes up.

How much foam? What you'll need for a boat depends on its flotation factor—the amount of weight it will support when submerged—and the extra weight that is put into the boat in the form of engine, passengers, anchors and other gear. The required buoyancy for various types and sizes of boats can be calculated from a chart called "Boat Flotation Formula," which can be obtained by writing to the Outboard Boating Club of America, 307 N. Michigan, Chicago.

As a rough guide, boats up to 14' in length generally require 400 to 500 pounds of extra flotation, or about 8 cubic feet of the foam. Boats 14' to 16' usually need 10 cubic feet; and boats 16' to 18', 12 cubic feet. This means that just about



TEMPORARY BULKHEADS cut from cardboard are used to seal off open spaces where liquid plastic will be poured in. Here, gaps below front seat are walled up so bow can be filled.

any average outboard can be sinkproofed with the two-gallon kit of chemicals.

How the foam is poured. Estimating exactly how much foam the liquid chemicals will make is tricky. For this reason, the plastic is poured in several layers until the desired thickness is built up.

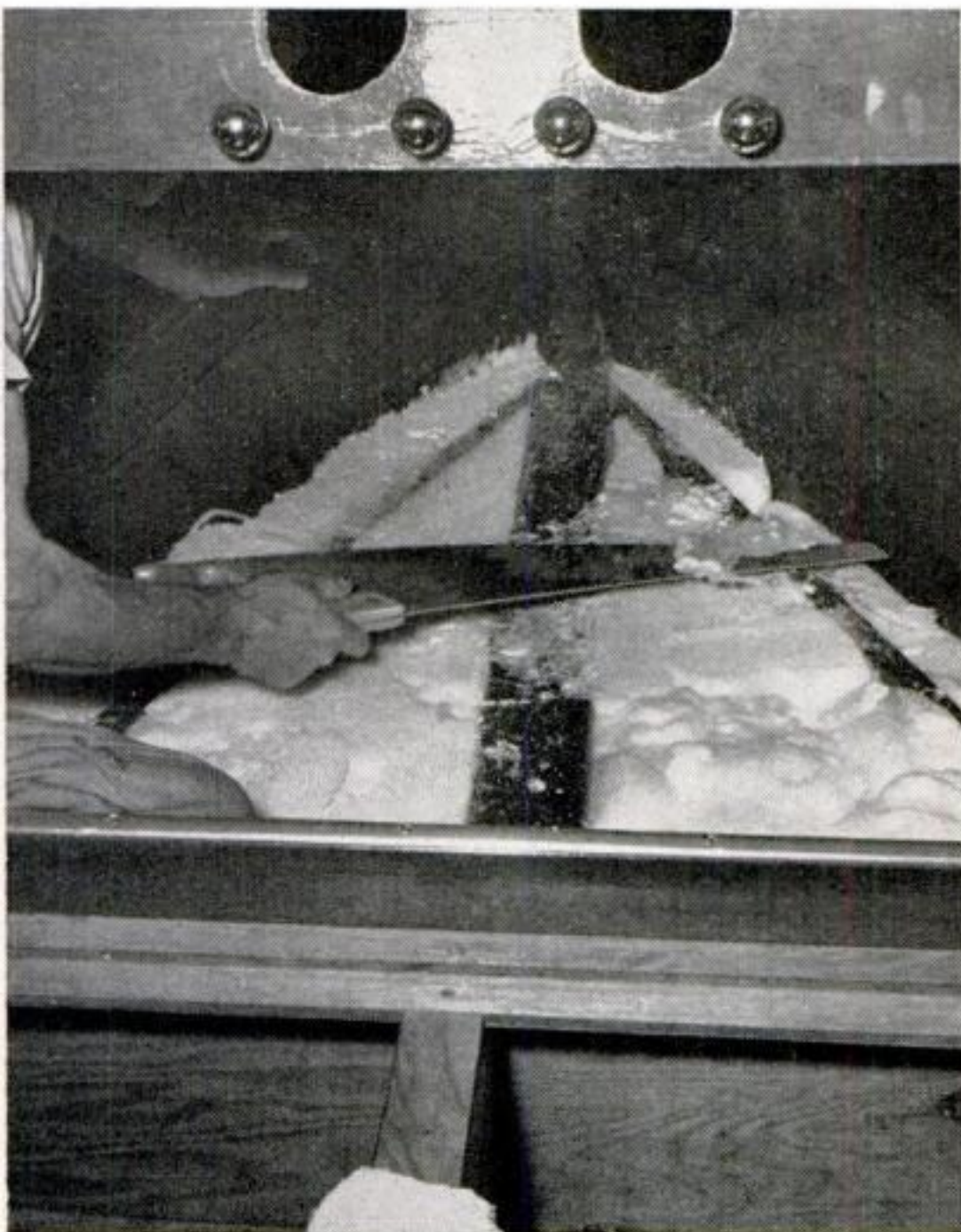
In closed spaces, it's important to underfill slightly. If too much plastic is poured in, the tremendous pressure of the expanding foam may actually burst seams or bulkheads. Vent holes must be drilled in the sides of such spaces to let off gases that are generated by the foaming process. The holes also serve as safety valves to let the foam escape harmlessly if too much is accidentally poured in. In spaces that are open at the top, the plastic can be overfilled without danger. Letting it overflow and then trimming off the excess is, in fact, an easy way to get a neatly flush fill.

In open areas, the liquid plastic is held in place until it foams with temporary dams cut from cardboard and attached

with masking tape. The cardboard is waxed to keep it from sticking and can be peeled off easily once the foam has set.

The foam should be placed as close as possible to the heaviest part of the boat—usually the stern where the motor, battery, tools, and other gear are located. The waste space underneath the motor well in many boats is an ideal spot to fill with foam. Other good possibilities are under seats, along gunwales, and in the hollow spaces between frame members and double-bottom hulls. The bow area, almost always useless, can be filled solid with foam, making it practically impenetrable to floating objects struck at high speed.

And one caution: The fumes given off by the foaming process are toxic and can be harmful to eyes and lungs. Once a pour is made, it should be allowed to set 20 minutes before further work is continued. The Safety Foam plastic is sold by Marvel Plastics Co., 1250 N. Parker St., Orange, California.



FOAM IS TRIMMED OFF FLUSH after it has set, making it possible to fill open areas fully and evenly. The foam hardens in about 20 minutes, can be cut with a saw blade or knife.



PAPER FUNNELS make it easy to pour the plastic into closed spaces through holes. Temporary bulkhead, taped on, will be peeled off later, leaving a smooth surface on the foam.

Mechanics and Handicraft SECTION

HOW TO BUILD **A Steam Turbine for the Savannah Model**



Part III. Love fine machining? Here's a high-revving power plant that gives the trim ship an astonishing half-hour run

By Herbert R. Pfister

YOU feel the throb of live steam, hear the mounting whine of a high-speed turbine rotor winding up to full speed. That's the power plant in the model Savannah—an authentic, powerful steam turbine similar to the one that drives the real Savannah. A most unusual piece of model machinery, it makes a fascinating and rewarding project.

Despite the tremendous rate at which the miniature turbine gobbles up steam, it gives you a surprisingly long run—a full half-hour on a single filling of the boiler. Unlike many other forms of model power, it allows you plenty of time to send the ship on long voyages without constant refueling or the fear that she may run out of steam far from shore.

Built by Floyd McGuckin, an expert machinist, the little turbine is as delicate as a jewel, yet is designed to be simple and accurate in construction.

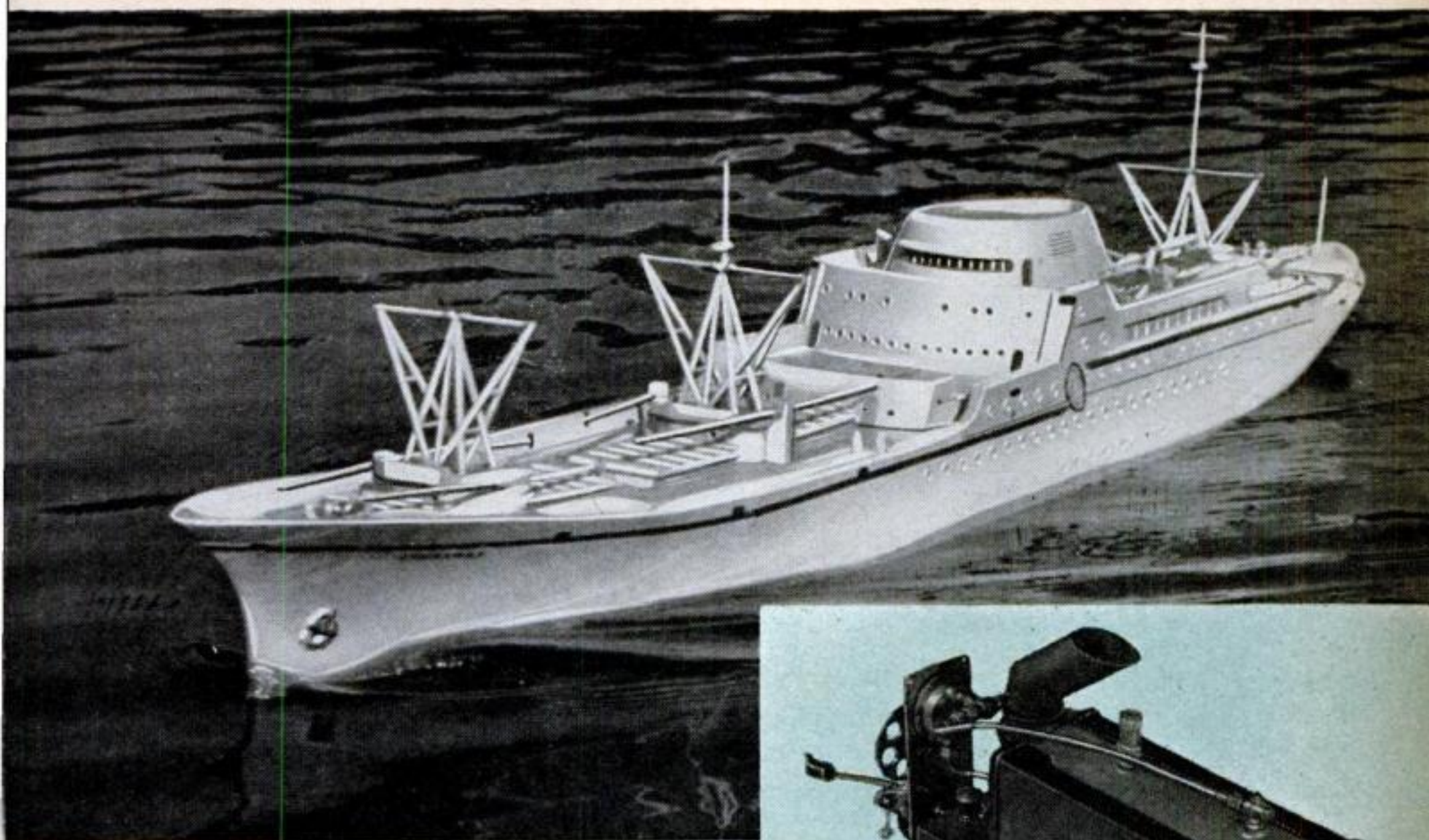
About the size of a silver dollar, the turbine rotor revs up to well over 5,000

r.p.m. under 50 pounds of pressure from a tiny jet of steam. The high revs are then tamed down through gear reduction to put out about 900 r.p.m. at the propeller shaft—enough to send the Savannah skimming along at a scale speed equivalent to her big sister's. Pull a lever and the mighty turbine goes into reverse, bringing the ship smartly to a halt or starting her steaming backwards.

The source of steam for the turbine is the only major difference between model and prototype: A nuclear reactor generates steam for the big ship; the little one gets her steam from alcohol burning on a cotton wick under a pint-sized boiler.

The rotor is the heart of the turbine. You could slot and bend a disk of sheet metal into a multibladed fan; but for maximum efficiency, the rotor should be machined from solid stock. Two easy-to-make jigs—one for indexing and one for cutting the blades—simplify the job.

Chuck a piece of 1½" machining-grade



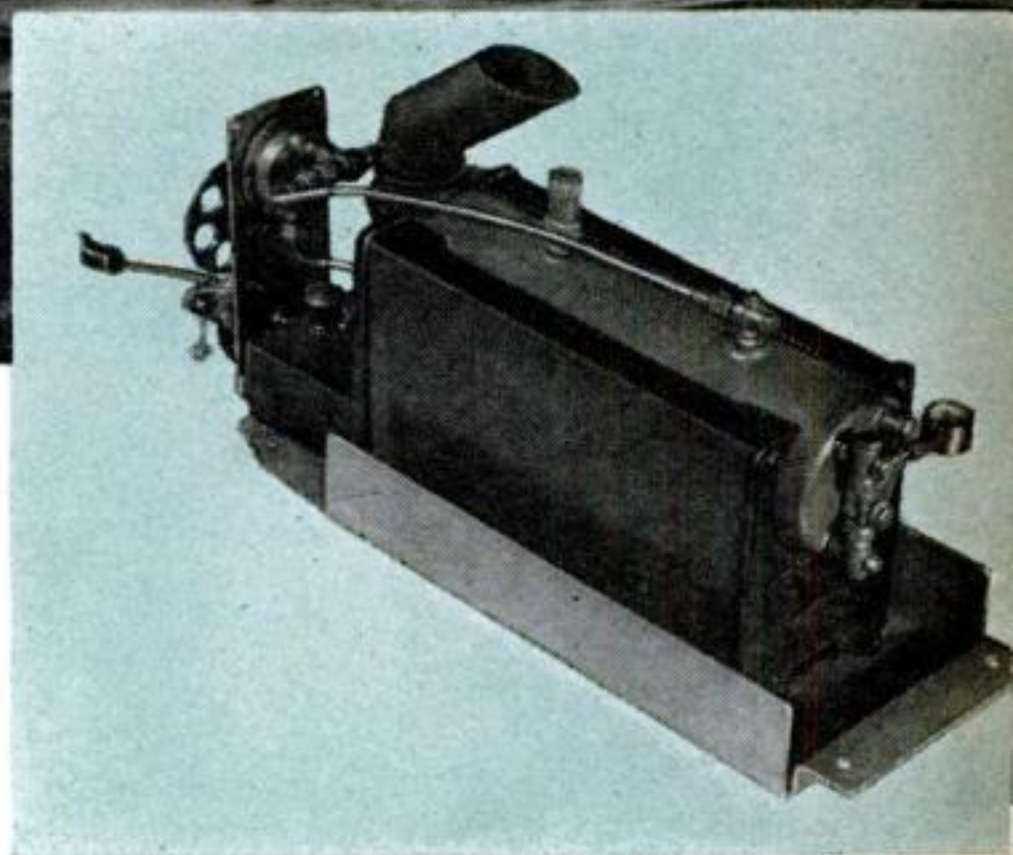
ROLLING UP A SCALE-SIZE BOW WAVE, the model Savannah knifes along under power from its jewel-like turbine (left). Boiler at right generates 50 pounds of steam to spin the turbine.

aluminum in the lathe, take a truing cut to reduce it to $1\frac{3}{8}$ ", and drill a $\frac{1}{8}$ " hole in its center. From this, cut off several $\frac{3}{8}$ "-thick disks for rotor blanks.

Bolt one of the blanks to a toothed gear—you use the teeth as an easy indexing jig to establish the position of the rotor's blades. Since the rotor has 24 blades, you can use any gear having 24, or a multiple of 24, teeth. If you use a 48-tooth gear, you count every other tooth. McGuckin used a 72-tooth gear and counted every third tooth.

Clamp a V-notched piece of plywood to the drill-press table, and to this clamp a pointed strip of metal. Adjust the plywood so that when the gear is placed in the V notch a No. A centerdrill in the drill press will be $\frac{3}{8}$ " to one side of the center hole in the rotor blank. The No. A centerdrill—not a regular A-size drill—is important for precise hole spotting.

Press the gear into the V notch with one of its teeth lined up with the metal pointer and drill the first indexing hole about $\frac{1}{16}$ " deep. Then rotate the gear to



the next tooth you're counting and drill the second hole. Continue turning the gear until you have 24 evenly spaced holes $\frac{1}{32}$ " in diameter and $\frac{1}{16}$ " deep.

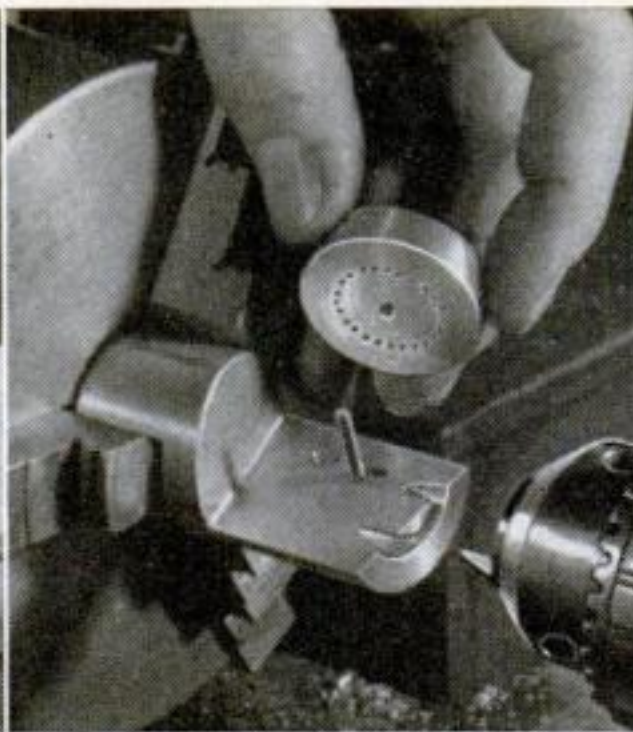
The blade-cutting jig is the second, and most ingenious, part of the rotor-making operation. Cut and file a step in the end of a $3\frac{1}{2}$ " length of $1\frac{3}{8}$ " aluminum rod. The step should be parallel to and slightly below the center line of the rod. At locations given in the drawing, drill and tap one hole for a stud, and drill a second hole $\frac{3}{8}$ " from the stud's center for the $\frac{1}{32}$ " indexing pin. The stud is made by cutting the head off a No. 5 machine screw.

Place a blank on the stud with the indexing pin engaging one of the 24 indexing holes and lock it in position with a No. 5 nut. Chuck the blade-cutter bit (see drawing) in the tailstock and slow-

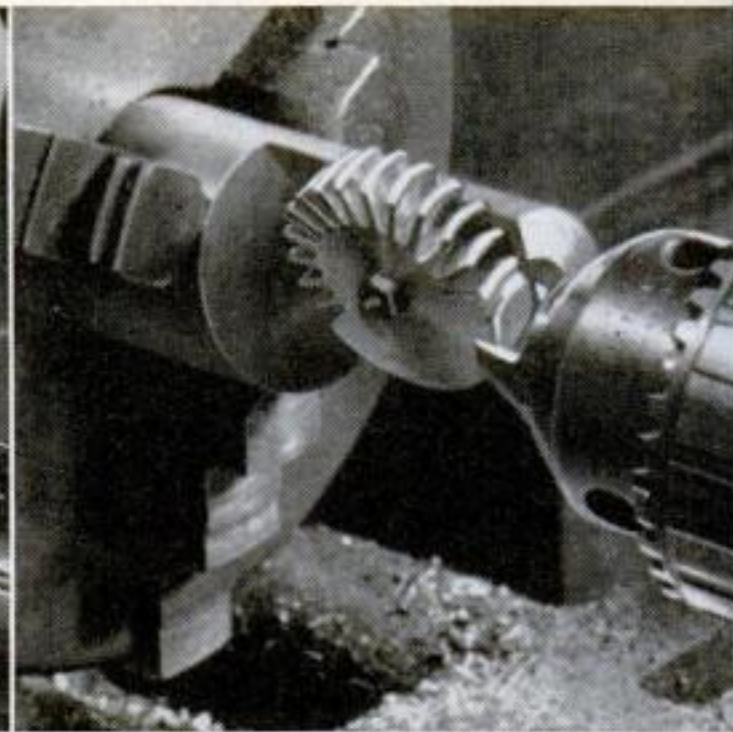
HOW TO MAKE THE TURBINE



INDEXING HOLES are drilled in a $\frac{3}{4}$ " circle around the rotor blank to locate positions for the 24 blades. With a simple jig—a gear rotated in a V-notched block—you can use the gear teeth to line up each hole accurately under the drill.



LOWER THE BLANK on the cutting jig so that one indexing hole fits over the indexing pin. Fasten the blank in position with a nut on the threaded stud. Advance the tailstock slowly to take the first arc-shaped cut in the rotor blank.



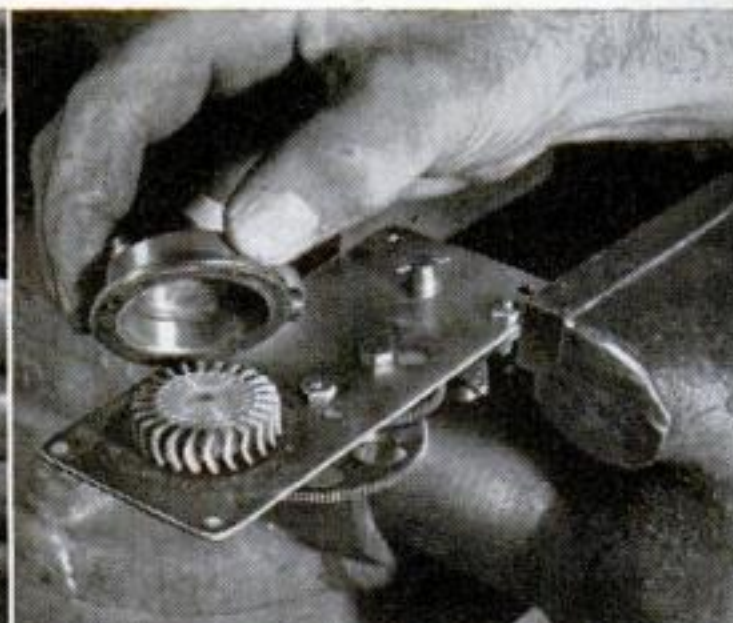
ROTATE THE BLANK after each cut, aligning the holes with the indexing pin. Here, turbine is half completed. As the lathe turns, the jig swings the edge of the rotor blank over specially made cutter held in the tailstock. Cutting depth is $\frac{1}{4}$ ".



COMPLETED ROTOR has 24 equally spaced blades around its edge. The curved cut in the jig was made by the cutter at the same time it shaped the blades. Note how the cut continues into the rotor blank to form the curve in the blades.



TURBINE HOUSING is machined from a $2\frac{1}{2}$ " disk of $\frac{1}{2}$ " brass (or it can be turned from $2\frac{1}{2}$ "-diameter rod). Solder the threaded sleeve for the valve over the steam-inlet hole as shown. Fitting for $\frac{3}{16}$ " exhaust tube is already in place.



HOUSING MUST FIT CLOSELY over the rotor, yet provide clearance so it can turn freely. After locating its position, clamp it to the brass plate and drill holes through the flange for the pilot pin and a half-dozen No. 3-48 mounting screws.

ly feed it into the blank until the cut is $\frac{1}{4}$ " deep, noting the depth on the ram calibrations. Note also the position of the tailstock handwheel for precise control of depth.

Loosen the locknut and rotate the blank until the next hole drops on the indexing pin. Repeat the operation until all 24 blades are cut. Remove the rotor from the jig and wire-brush it lightly to

CONTINUED

**Don't go in
for machining?**

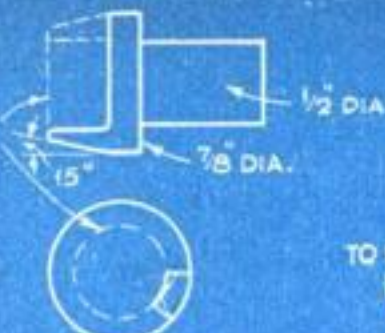
**Buy the Parts
You Need**

You can buy any or all of the parts required for the Savannah's steam-turbine power plant, including the complete assembly, boiler and all, ready to connect to the prop shaft of your model. For information, write to Floyd McGuckin, 314 North Monroe St., Ridgewood, N. J.



1 3/8 ALUMINUM ROD

RIM GROUND AWAY EXCEPT PART USED FOR CUTTER



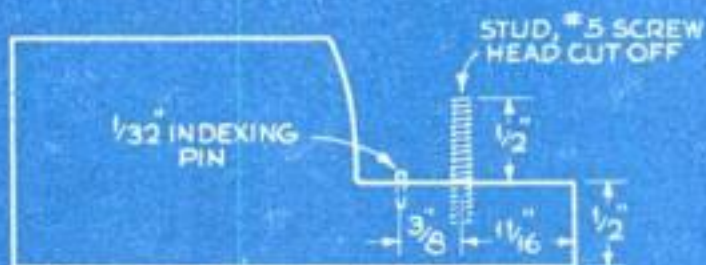
BLADE-CUTTING BIT



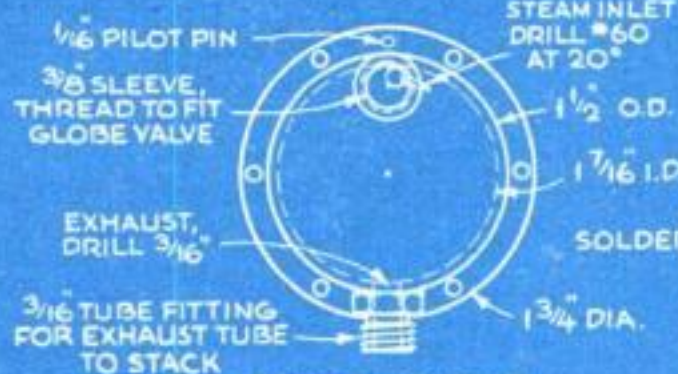
TURN OR FILE OFF NEEDLE POINT FOR FASTER OPENING



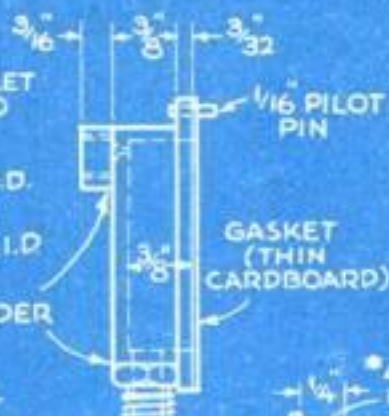
GLOBE VALVE



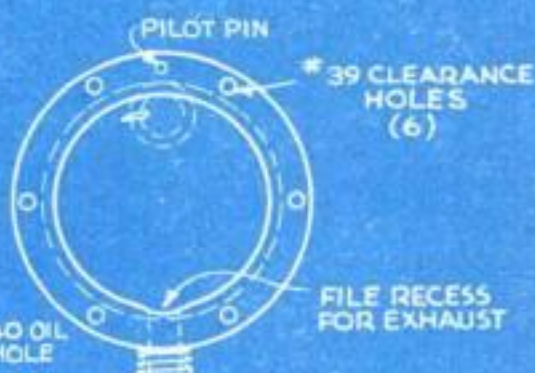
BLADE-CUTTING JIG



ROTOR HOUSING



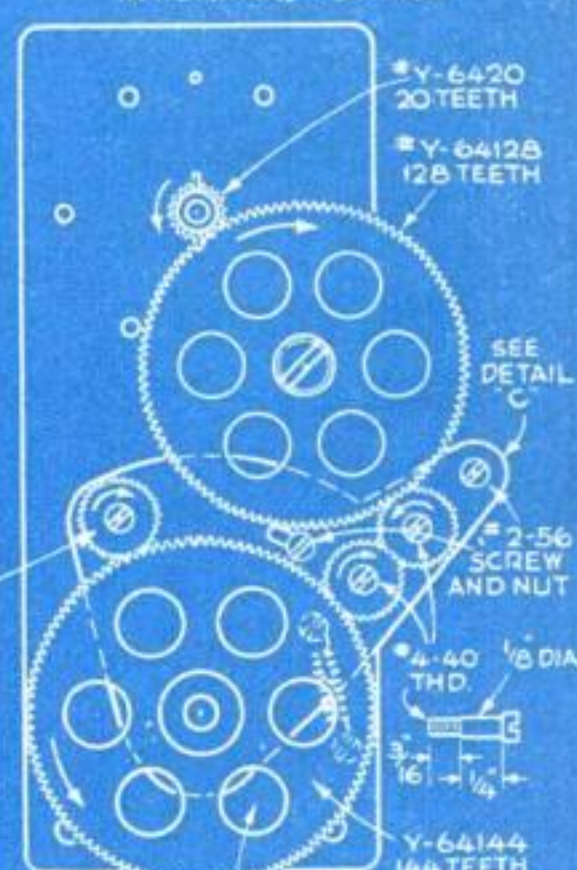
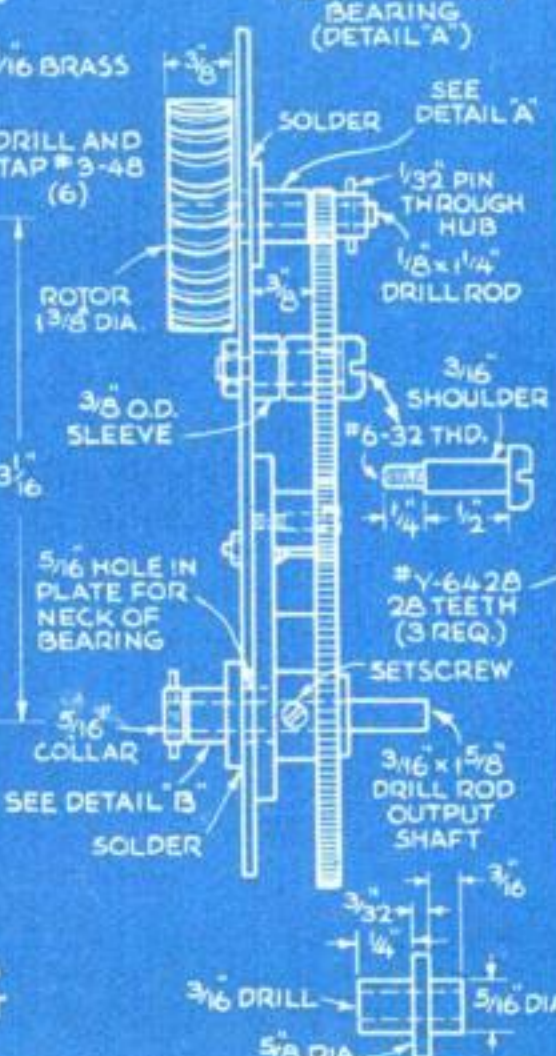
TURBINE-SHAFT BEARING (DETAIL A)



ALL GEAR NUMBERS, BOSTON GEAR WORKS



TURBINE-ROTOR AND GEAR-REDUCTION UNIT



NOTE: GEARS SHOWN IN FORWARD POSITION



FLEXIBLE COUPLING

OUTPUT-SHAFT BEARING (DETAIL B)

REVERSE IDLER (DETAIL C)





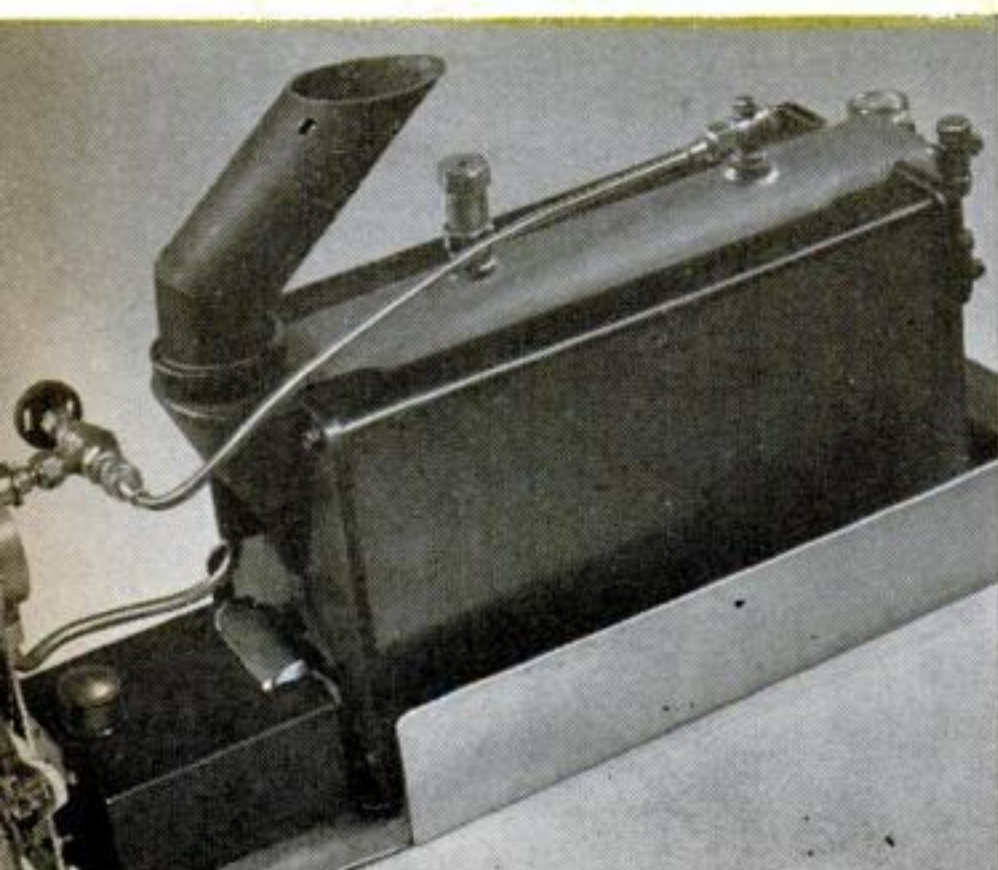
REDUCING THE

TURBINE'S SPEED

GEARS TAME THE TURBINE. Several combinations of prop pitch and shaft speed were tried before the little Savannah cut a scale-size bow wave. The gearing shown did the job, reducing turbine speed 6 to 1 to turn the prop shaft at about 900 r.p.m. The pivoted idler plate, shown in reverse position above, is moved upward to engage the other two small gears for forward motion. The turbine rotor, located at the back of the gear plate, is shown at right.

ASSEMBLING THE POWER PLANT

STEAM IS PIPED from boiler to globe valve on the turbine. Aluminum tray supports the boiler, alcohol tank, and gear train. Boiler is an English-made Stuart-Turner, Model 500, priced at \$18 with burner, water-level gauge, and globe valve. Pressure gauge is extra at \$5.50.



deburr the blades. Press a $1\frac{1}{4}$ " length of $\frac{1}{8}$ " drill rod in the center hole.

Machine the rotor housing from a $2\frac{1}{2}$ " disk of brass $\frac{1}{2}$ " thick. Make the housing recess exactly as deep as the thickness of the rotor. A thin cardboard gasket between the rotor housing and the gear plate will provide clearance for the rotor and keep steam from leaking out.

The steam-inlet orifice must be drilled at an angle of 20 degrees for maximum thrust against the turbine blades. You can keep the bit from slipping by first drilling a shallow $\frac{3}{16}$ " hole about $\frac{1}{64}$ " deep at right angles to the housing surface. Then clamp the housing at the 20-degree angle and drill into the side of the shallow hole with a No. 60 drill.

Making the gear-reduction unit is simply a matter of laying out the specified gears and drilling holes in the plate for their shaft screws. All of the gear numbers given on the drawing are available from the Boston Gear Works at 14 Hayward St., Boston.

For minimum friction, the gears should mesh easily—even have a slight lash when rotated back and forth against each other. Only the high-speed turbine shaft requires a bearing. This is made by pressing two $\frac{1}{8}$ " Oilite bushings into a sleeve soldered to the gear plate.

Connect the output fitting on the boiler to the globe valve on the turbine inlet with $\frac{3}{16}$ " copper tubing. Run a short length of tubing from the turbine exhaust to the exhaust hole at the bottom of the boiler stack. With this arrangement, exhaust steam goes up the stack with the heat from the alcohol burner.

A bench test of the power plant comes next. This is the big moment. Pour water into the boiler until it is two-thirds full, and fill the tank of the burner tube with alcohol. A sardine can or shallow tray bent from aluminum is handy for firing up the burner. Pour a thimbleful of alcohol into the tray beneath the wick tube and light it. The brief flame will heat the tube and vaporize the alcohol, which will then burn until the fuel is gone.

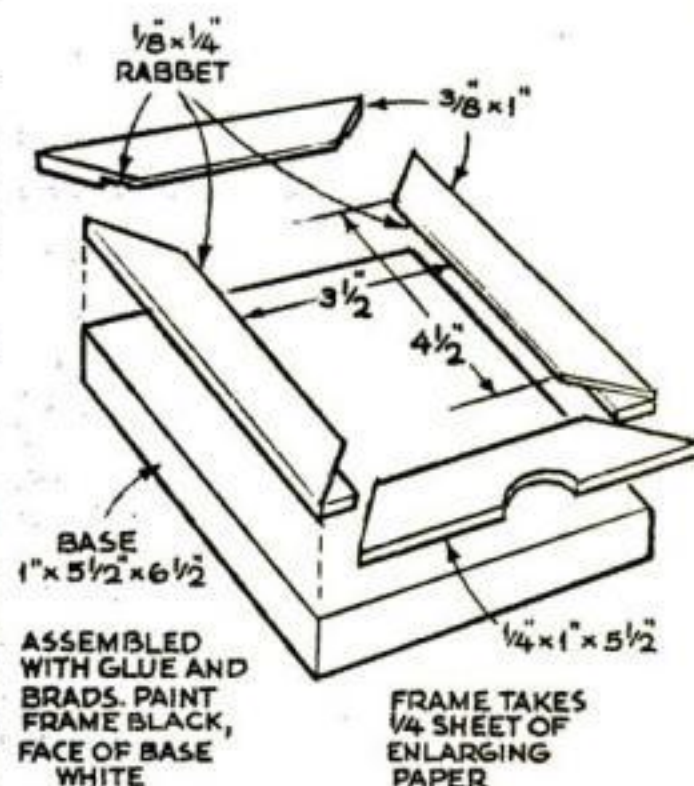
In five minutes, you should see 50 pounds of steam on the gauge. Open the globe valve to admit steam to the turbine. The rotor should pick up speed rapidly, the high-pitched turbine whine rising in proportion to speed.

[Continued on page 192]



Short Cuts and Tips

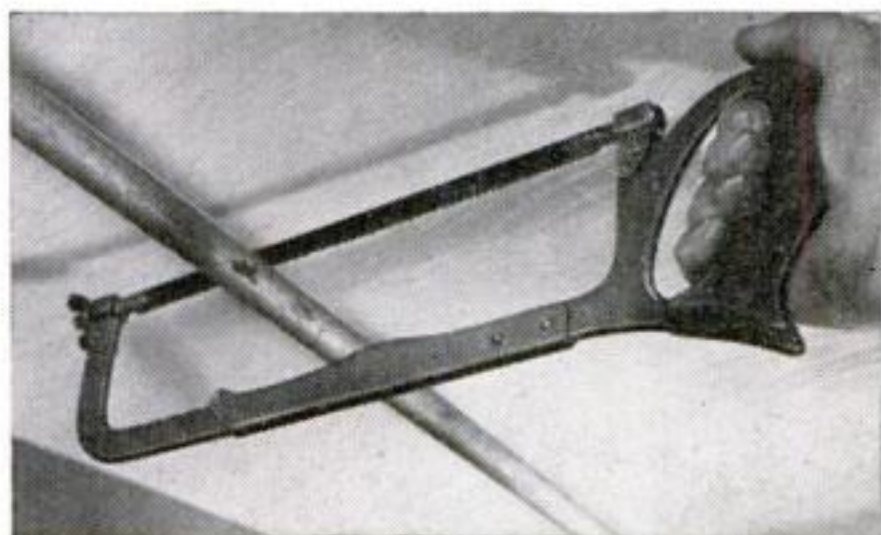
FROM PS READERS



Saves Enlarger Adjustment

To JUDGE whether a small negative is worth blowing up, make a half-size enlargement first. Printed on projection paper, a 4-by-5 proof tells you what an 8-by-10 will look like. With this auxiliary platform and printing frame, your enlarger is set to make either, without ad-

justment, and your easel can be kept set for 8-by-10 prints. The platform is a plywood box. To determine its height, focus a negative for an 8-by-10 image and measure the distance from lens to easel. Lower the head, refocus for a 4-by-5, and measure again. The difference is the height of the proofing platform.—*Jackson Hand, Westport, Conn.*



What Would You Do ?

...if you had to saw off
a pipe or rod overhead,
near the ceiling

You could, of course, saw upwards from below. But that's difficult and tiring with a hacksaw.

Instead, remove the blade and reassemble the saw around the pipe with the

teeth downward—if there's room above the pipe or rod for the blade. That way gravity will work for you, not against you, as you make the cut.

Darrell Huff, Pacific Grove, Calif.

Gadgets Any Photographer Can Afford



LEVELING DEVICE prevents distortion and tipping in critical setups, yet few cameras have one. A carpenter's line level is small, light, and rugged enough to carry anywhere.



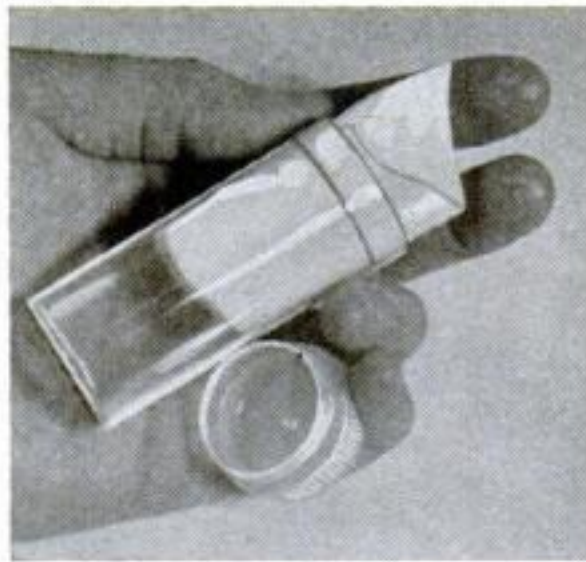
SMALL BULB SYRINGE can be used to blow dust from lenses and hard-to-clean corners inside cameras. Keep it handy, too, by your contact printer or enlarger, for dusting negatives.



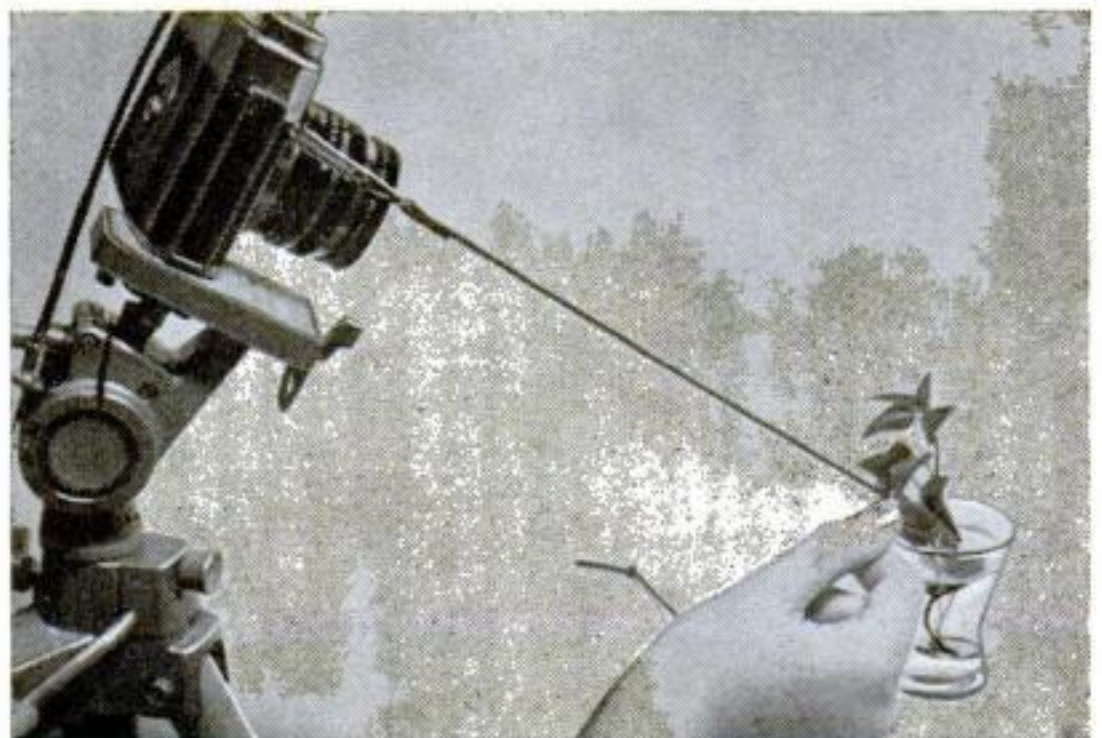
TINY DISPENSER BOTTLE, of the kind you get at drugstores nowadays to apply eye or nose drops, will plink out a single drop of lens-cleaning fluid right where it's needed.



PLASTIC BAG, folded into a strip, eases removal of batteries from the compartment of a flash unit. Lay strip across compartment, fold the ends over, and close the case.



PLASTIC PILL BOTTLE with a tight-fitting cap keeps lens tissue clean and dry in your gadget bag. Because it's plastic, there's no danger of broken glass or corroding metal.



CORD SHOELACE with knots tied in it at the most used picture-taking distances makes a tape measure unnecessary for portrait-lens work. Tie to shoulder-strap lug and use it as below.



CALIBRATED MEDICINE DROPPER is an accurate dispenser for adding film-wetting agent to the final wash water in your developing tank. Use 0.6 cc. of agent for each 3 oz. of water.

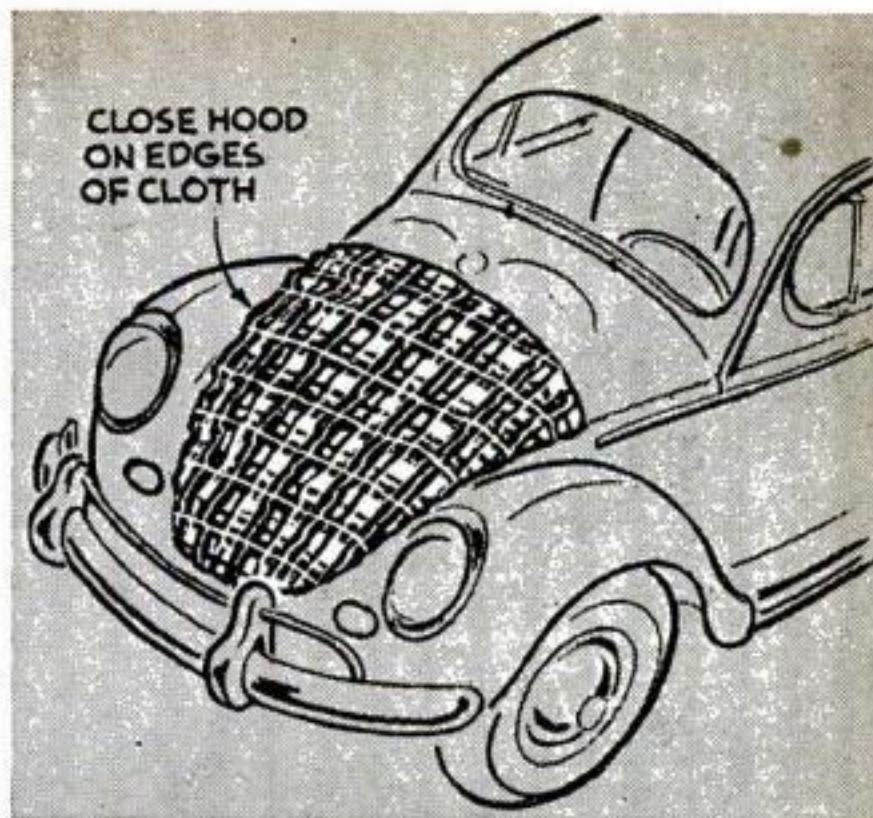


LIGHTER FLUID cleans grit and old adhesive from the felt of a used 35-mm. cartridge so you can reload with bulk film. Remove both ends, spread the casing gently to open the lips.



IMMERSION COIL (intended for travelers who want to heat up a drink in a hotel room) will quickly warm a photographic solution to the specified darkroom temperature.

By
Joseph R. Noonan



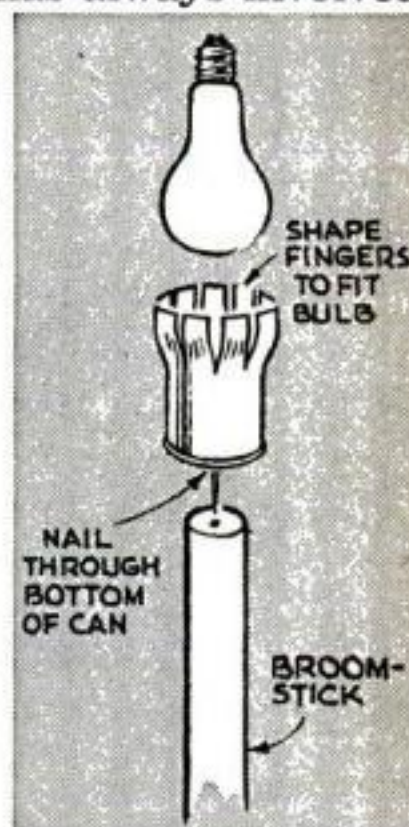
Hood Cover Protects Paint

THE sloping snouts of grille-less European cars are vulnerable to stones kicked up by passing traffic. When you drive gravel roads, keep the finish from getting pock-marked by tucking an old blanket around the lower part of the hood.—*Torsten Gustafson, Malilla-Kyrkby, Sweden.*

▶▶▶ WHEN reclaiming used bricks, you can remove the dried mortar more easily if you pile the bricks, wet them with a hose, and let them stand overnight. Moisture penetrates and softens the mortar, so it can be removed with less damage to the bricks. Wetting also eliminates most of the dust that usually goes with mortar chipping.—*M. R. Beasley, Detroit.*

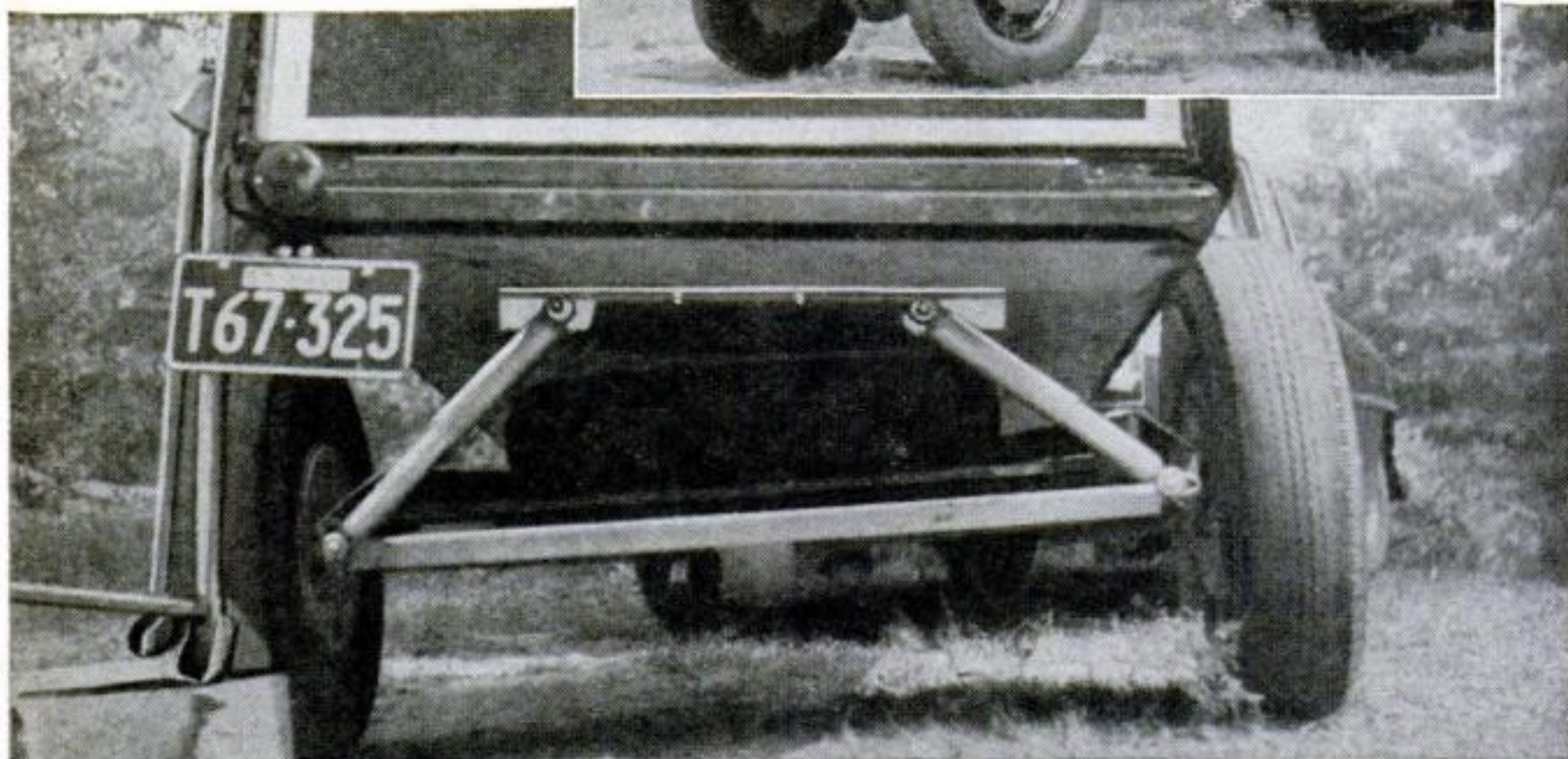
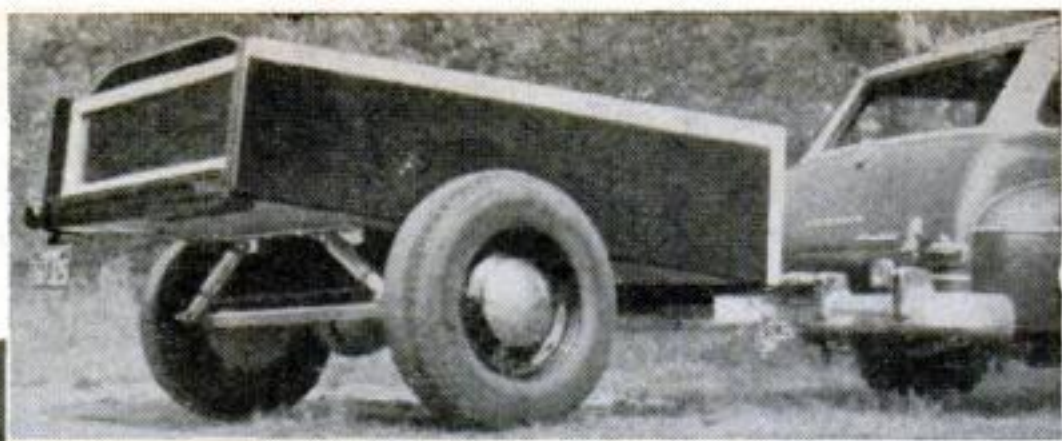
Replacing Out-of-Reach Bulbs

PUTTING a new light bulb in the ceiling socket of our garage has always involved a balancing act. The stepladder isn't quite tall enough. Now, however, I have a long-reach gripper. I snipped a series of 2" cuts down from the rim of a can, and bent the strips to the shape of the bulb, making sure they kept their spring tension. These fingers unscrewed the old bulb, put in the new one.—*Mrs. A. M. Nichols, Azilda, Ont.*



Short Cuts and Tips

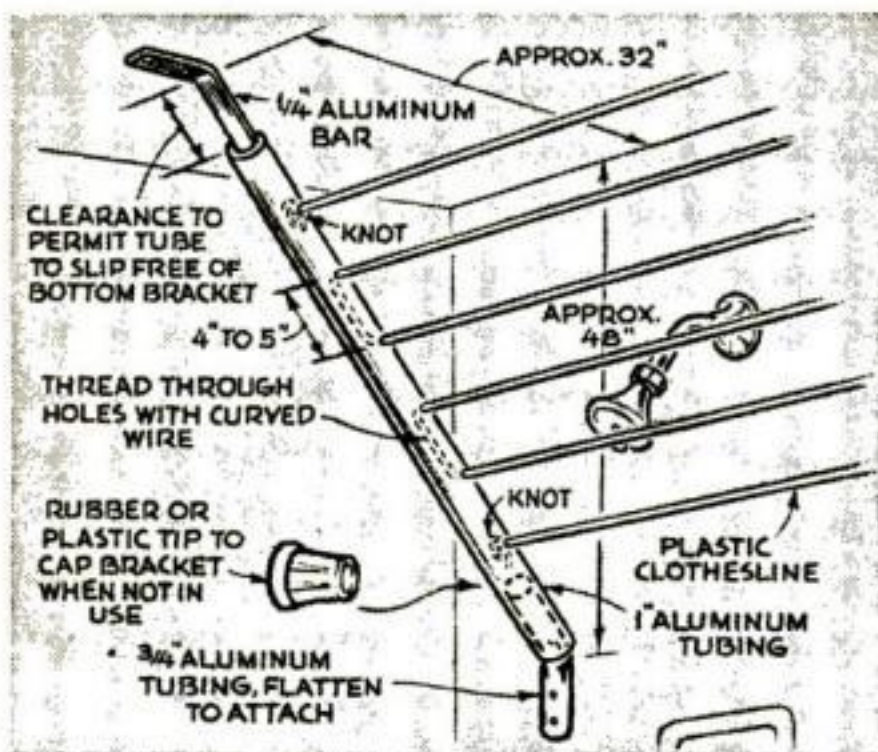
FROM PS READERS



Tire Serves as a Spring

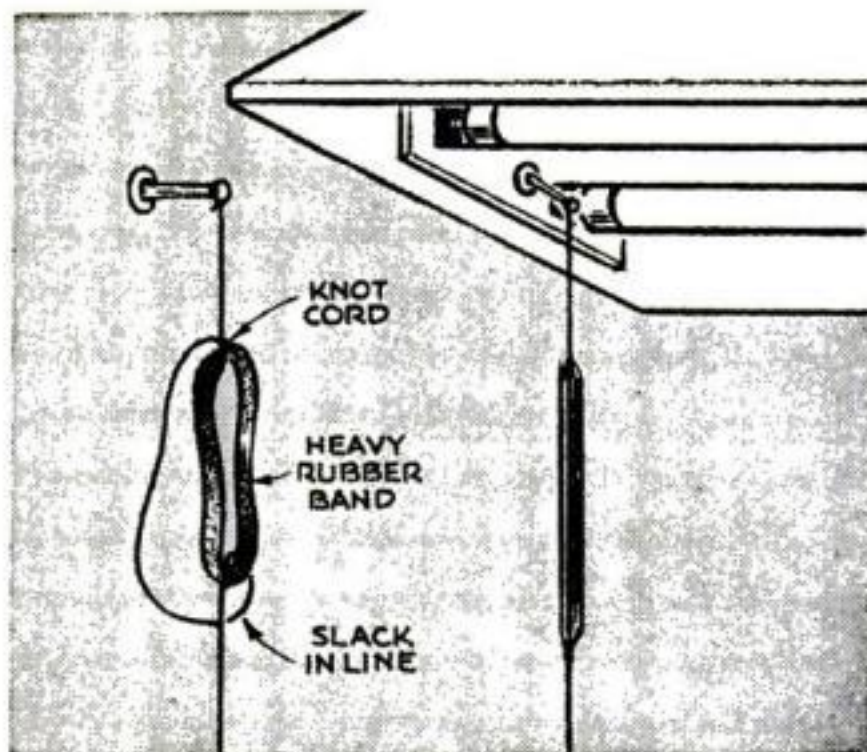
THE utility trailer I just built has an unusual feature: air suspension. A truck-tire tube inside a rimless auto-tire casing supports the body of the trailer. It rests

on a plywood frame above the axle. Very little air pressure is required, and it can be varied for different loads. A pair of shock absorbers provide the necessary snubbing action for a smooth, stable ride.
—Ken Boyea, Springfield, Mass.



Removable Drying Rack

THE space over the tub is ideal for an indoor clothesline. This rack—two tubes with line strung between them—bridges a ceiling corner. The tubes slip onto permanent brackets that protrude from wall and ceiling. When the rack's not up, the wall brackets double as safety grips.—*J. E. Russo, Portsmouth, Va.*



Pull-Cord Shock Absorber

SUDDEN jerks often snap the pull cord on a ceiling light fixture. I got tired of dragging a step ladder all over the plant where I'm a maintenance mechanic. I have cut down on breakage by splicing a rubber band into each cord. It cushions the shock and works the switch smoothly.
—*Robert B. Ryan, Torrance, Calif.*

How to Live Better with Steam Heat

A HOME steam-heating system works, in some ways, like the system kids use to divide one soda—"three straws, please." The cooperative system works fine unless one of the youngsters has considerably more—or less—"draw power" than the others.

A steam-heating system has "draw-power" problems, too.

Each radiator draws steam from one central boiler. Each must compete for its full share of steam, but the cards are stacked in favor of some. Unless measures are taken to equalize an unequal competition, some rooms will be too hot—others too cold.

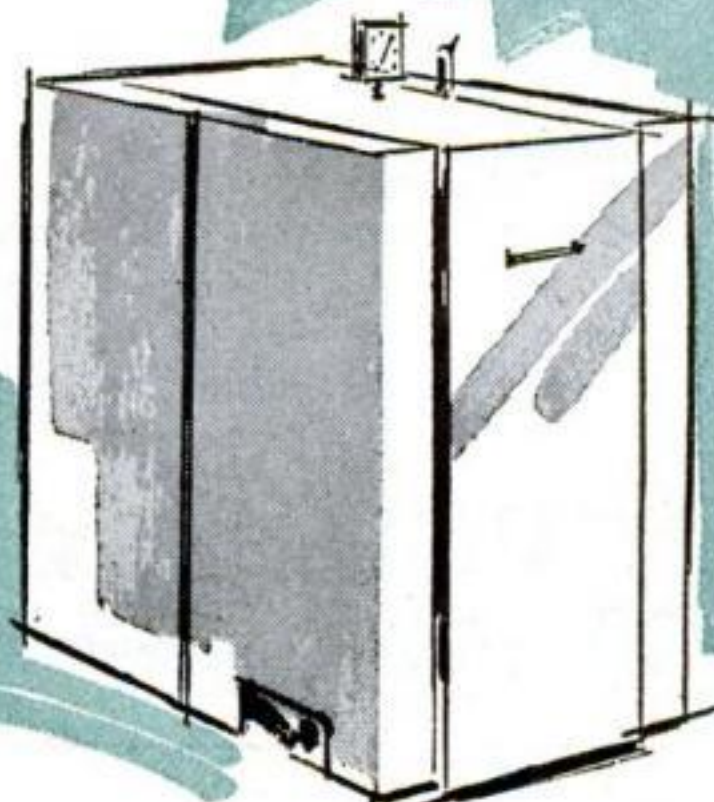
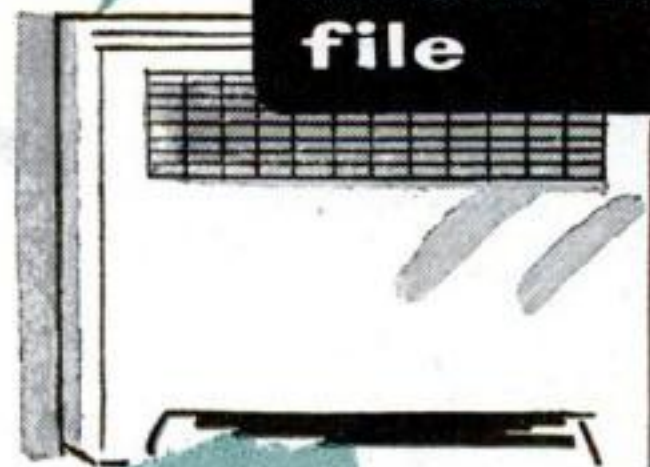
Some of the symptoms of draw-power problems are:

- Chronically cold radiators.
- Radiators with only a few sections that heat.
- Top-heating radiators.
- Radiators that are steam gluttons.

On the following pages, in words and pictures, you'll find solutions to many problems, along with tips to save you money and improve your comfort. You'll also find a "how it works" description of a standard steam-heating system that may also help you get the most out of your heating plant.

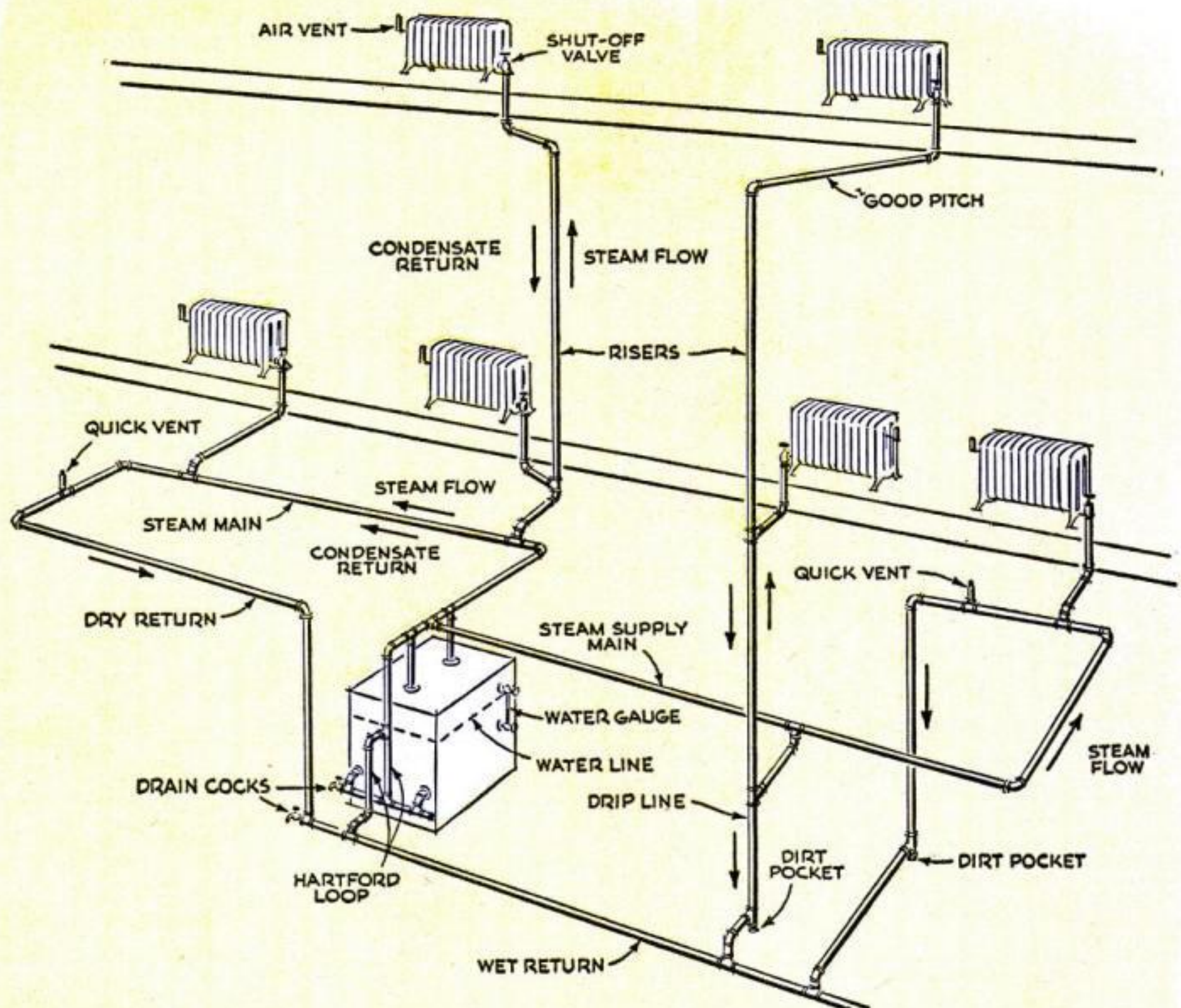
After you have each radiator working at peak efficiency, turn to the Five-Step Balancing Program.

know-how
file



CONTINUED

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HOW IT WORKS

THE usual home steam-heating plant is a low-pressure, one-pipe system—i.e. the operating steam pressure is between zero and 15 p.s.i., and steam and condensate flow through the same pipe. When cold, the mains, risers, and radiators are filled with air.

When the fire comes on and the steam pressure rises, the steam moves through the pipes toward the radiators, pushing the air ahead of it. Thermostatic vent valves on each radiator allow the air to escape so that steam can fill the radiator. When steam reaches the valve, a thermostatic spring or bellows closes to prevent loss

of steam. When the valve cools, it opens and allows air to flow back into the system again.

A similar installation called a vapor, or vapor-vacuum system, differs in one important respect: The vent valve does not readmit air to the system. Operating pressure is generally lower and may sometimes be below atmospheric pressure. The advantage is mainly in maintaining a more uniform temperature throughout the system. But it must be designed and maintained completely airtight to be effective.

In either case, the steam gives up its heat to the radiator and in so doing

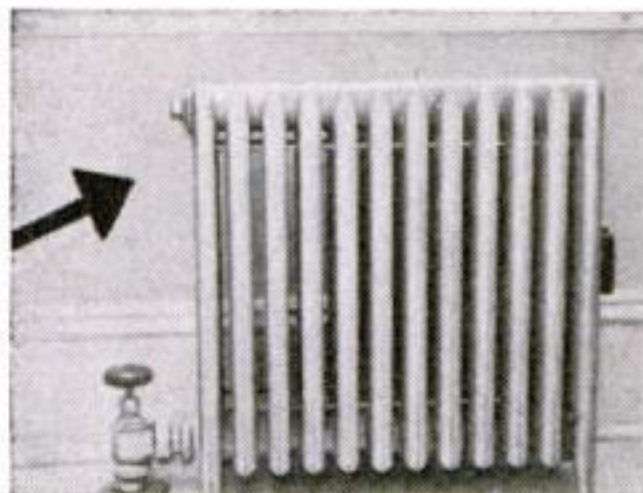
condenses into water. This makes room for fresh, hot steam to enter the radiator. The condensate flows by gravity back through the single pipe toward the boiler. Somewhere back along the line, the liquid separates from the dry steam line, flows into the wet return and re-enters the boiler below the water line. To expedite the return flow, there may be a pipe, called a drip line, connected to the point where a branch line leads off the main. It drops straight down to the cellar floor and runs along the floor to the wet return.

The shut-off valve at each radiator is there for only one purpose: to remove the individual radiator from the heating circuit. It should always be turned all the way on, or shut off tight. Not only is it ineffective in modulating the amount of heat, but operation with the valve partly closed may cause the radiator to fill with water and allow loss of steam around the valve stem.

Ideally, no boiler water is lost in the heating cycle. You keep using the same water over and over. In practice, there will always be a slight loss even in the best systems and you have to add boiler make-up water from time to time. Most home owners know the dangers of operating with the water level too low, but many are not aware that too much water can seriously restrict the steaming capacity of the boiler. If there is no water line marked on the boiler, a good rule of thumb is to keep the water-gauge glass between one-third and one-half full.

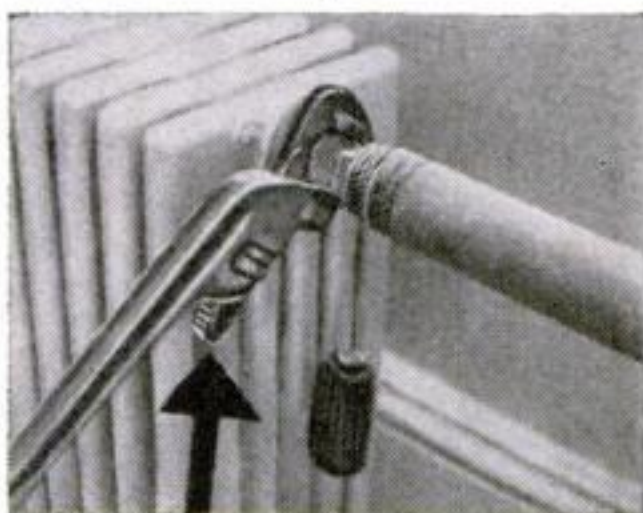
Steam leaking from anywhere in the system can cause a boiler to be chronically "thirsty." Faulty radiator vent valves and leaky packing around the stems of individual radiator shut-off valves are frequent offenders. Water leaks in a return line buried in the cellar floor, or pinhole leaks in an operating boiler, are possible causes for mysteriously high make-up water demands. In the latter case, tiny streams of water may spurt from the boiler when it's operating and be immediately evaporated by the heat—leaving no telltale signs.

13 steps toward getting more heat for your money

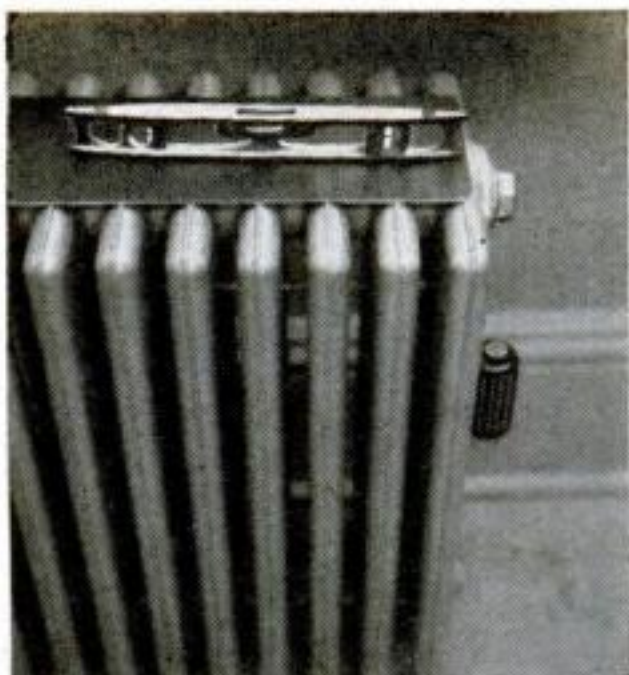


1 *Insulation pays off* in fuel savings and comfort, even if it is only a few square feet directly behind radiators. The walls behind a radiator may reach a temperature of 100 degrees or more on the inside. Because of the considerable temperature difference between the inside and outside of the wall, heat flows out at a rapid clip and is wasted. Rate of outward heat flow is proportional to temperature difference.

2 *Vent valves should be properly seated, upright and tight.* If water collects in the valve, unscrew it, shake out the water.



3 *A top-heating or short-circuiting radiator* is not carrying its share of the heating load. Steam entering these units flows across the top and causes the vent valve to close before the entire radiator is filled with steam. A cure that often works is to remove the top radiator plug and insert a piece of pipe the length of the radiator. The pipe should be as large as will fit in the hole and should be closed at both ends. Replace the plug. The pipe helps force the steam to circulate before it reaches the vent valve.



4 Radiators should tilt toward the end with the hand shut-off valve. If the radiator is level or pitched the wrong way, water will collect in it and partially or completely block incoming steam. Check with a level, and shim up the radiator feet to get a definite pitch.



5 Keep radiators clean of dirt, dust, and household fuzz. They restrict heat transfer and circulation of warmed air.



6 Do not obstruct radiators; odds and ends stacked on a radiator, or furniture in front of it, block, absorb, or divert heat from the rest of the room. Be sure any enclosure around a radiator is designed to promote air circulation through the radiator. There should be an adequate opening at the bottom to admit cool air

and another at the top of the front face to allow warm air to flow out into the room. It is especially important that the wall behind enclosed radiators be well insulated.

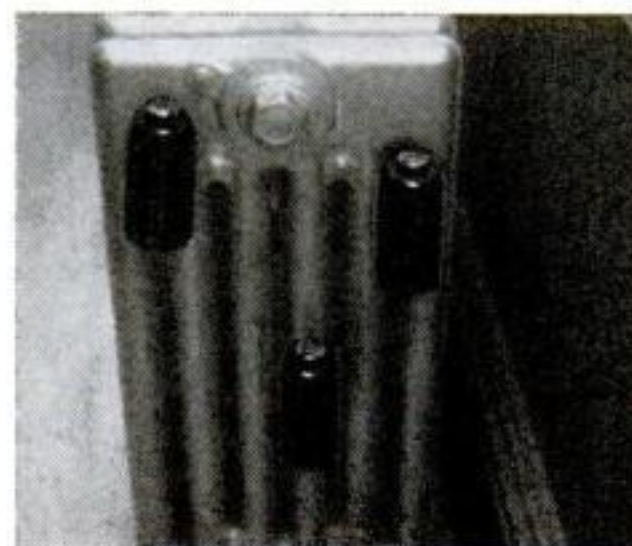


7 Obstructed vent-valve holes, plugged or painted over, will keep a radiator from heating properly. The same brand and kind of vent valve is preferable on all radiators in a system.



8 Use automatic, adjustable vent valves if your boiler is automatically fired. Fixed vent valves are suitable for coal-fired furnaces that maintain a long, steady heating cycle. But if you convert to oil or gas, you should switch to the quick-venting, adjustable valves.

9 Stubborn radiators that won't heat properly can often be helped by multiple vents. If adjusting the vent to the fastest rate still leaves a radiator cold when the rest of the system has been heat satisfied, drill and tap for extra vents.

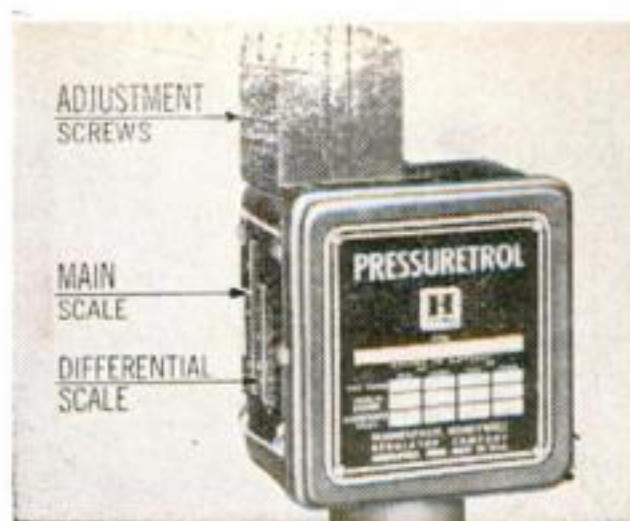




10 *Insulate steam mains and risers* because bare pipes carrying steam from the boiler to the radiator waste heat. They also slow the response of your radiators when heat is called for.

11 *Install quick vents* in the steam mains in the cellar. These quickly purge air from the supply lines and allow steam to reach radiators with less delay.

12 *Have limit control adjusted* to avoid excessively short, frequent firing cycles. There are two adjustments: main scale and differential. The control shuts



the fire off when boiler pressure equals main-scale setting *plus* the differential. The fire can come back on when pressure drops to the main-scale reading, if the thermostat upstairs is still calling for more heat.

13 *Low, narrow radiators* do more heating than tall wide ones. Two smaller ones are generally more effective than one big one. Radiators along an outside wall, preferably under a window, will make a room more comfortable than the same area of radiation placed along an inside wall.

How to balance your steam-heating system

When you have solved individual radiator problems, you are ready to balance the entire system. Here are the steps:

1. Choose a day when low outside temperatures will allow the system to operate without overheating your house. Begin from a cold-radiator start. Push the thermostat up high enough to require continuous boiler operation.

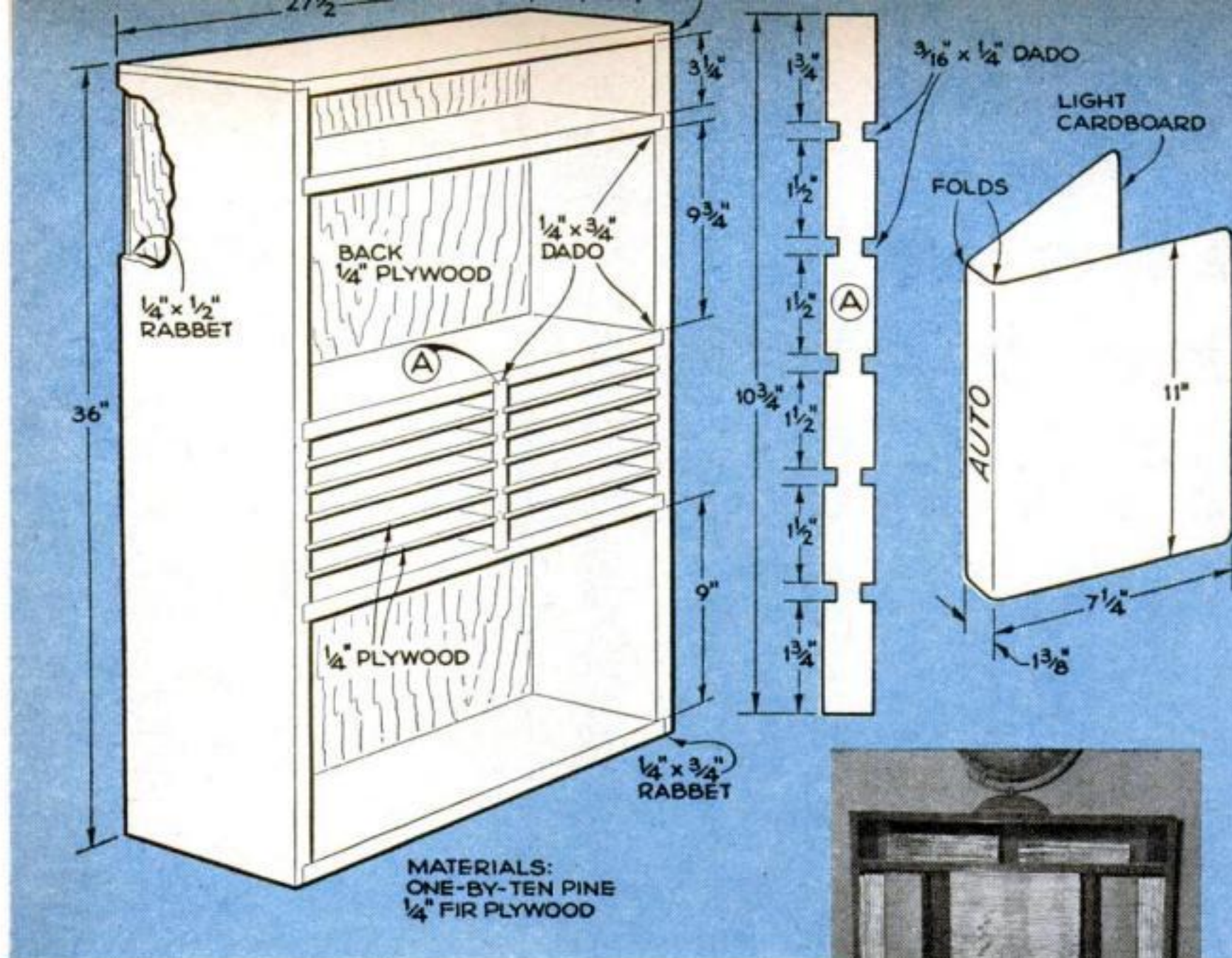
2. After 15 to 30 minutes, check all radiators for the number of sections that are warm up to this point. Only the first section or two may be warm on some. Some may still be completely cold, others uniformly hot.

3. To begin adjustment program, regulate vents by turning or screwing the adjustment knob. For radi-

ators heating faster than average, close down one notch; for those heating slower than average, open up a notch.

4. Rerun test several times until all radiators heat uniformly.

5. If certain radiators are still too slow to heat, they are probably far from the boiler. Check the steam mains to be sure there is a quick vent near the end. If there is one and it is working okay, you can still help by double or triple vents in the cold radiators. If there is no quick vent in the main, have one installed. You will then need to re-balance the whole system.



Rack for Storing Popular Science Articles

DO YOU have a growing pile of magazines, POPULAR SCIENCE and others, that you hate to throw out? To store mine, I built the cabinet you see here. On the top shelf I keep the latest 12 or so issues for future browsing. Below, in a series of labeled folders, I store valuable articles removed from older magazines, all indexed so they can be found without fuss or bother.

After building the storage rack and making a batch of folders, here's how you can tackle your own pile of magazines:

First put aside those for the browsing shelf. Then select the newest issue in the discard pile, remove the staples, and pick out the material to be saved. Staple the separate articles and file them in the appropriate folder. By starting with the newest issue, you get up-to-date material and often won't have to bother with a lot

of older articles on the same subject.

On the second shelf you have space for two midget file boxes—3" by 8" by 9 1/2"—for storing your POPULAR SCIENCE Reference Library inserts and any other small booklets. On the bottom shelf I store the best of my hobby magazines. To cut indexing to a minimum I use a code to note the location of the articles, such as "PS 260-13," which means POPULAR SCIENCE, February 1960, page 13.

It's a lot of fun going through your magazines again with a definite purpose. You will run across many items that you never saw before or paid little attention to. You will condense that huge pile to a reasonable size and you'll be able to find what you're looking for. Without the system, the pile is good only for browsing—you'll never be able to find a particular article.—*Julius Thauer, Pittsburgh.*

Facts About the New PSTs*

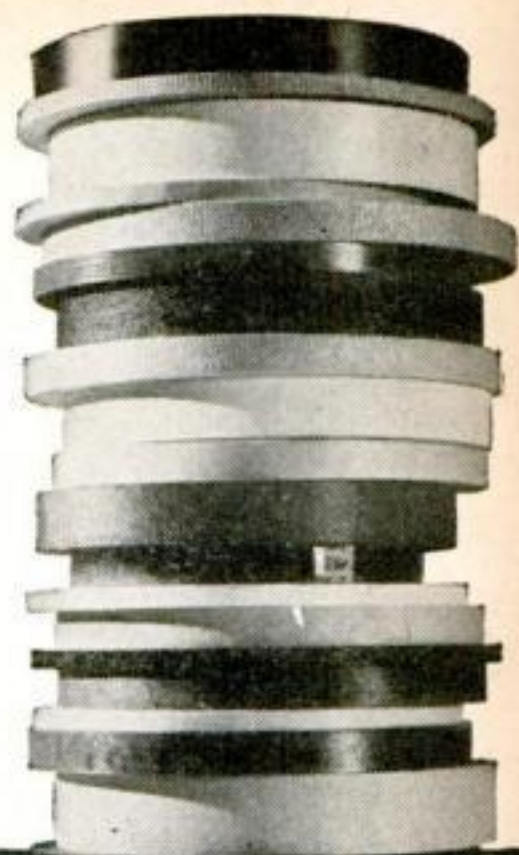
materials
file

***Pressure-sensitive tapes are worth knowing about. Plastic, nylon, cloth, paper, metal—you name it, they've made a tape of it**

IN HOME and shop nowadays, pressure-sensitive tapes are just about indispensable. They're ready to lend you a hand with countless woodworking, painting, decorating, repair, and handicraft jobs. They stick like glue, can be stronger than rope, and at times make an acceptable substitute for paint.

You can classify modern tapes in five categories depending on the backing used in their manufacture—paper, film (including the plastics), cloth, filament, and metal. Most of them have a rubber-base adhesive that clamps a firm grip on anything the tape touches. But don't judge a tape's sticking strength by how sticky it feels to the touch. Some that feel barely tacky have tremendous holding power. Some that feel very sticky will not hang on half so well.

The tapes are available in widths from $\frac{1}{4}$ " up to 4", and are made in a spectrum of colors. Some types, such as the plastics,



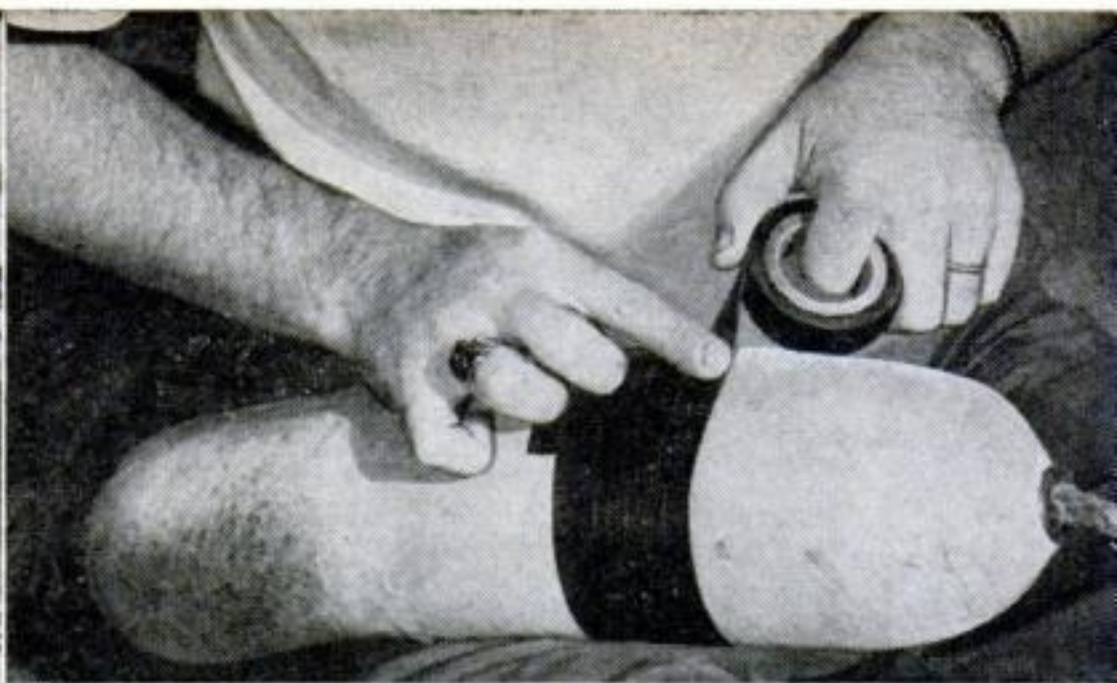
PAINTING A BOAT? REPAIRING A CORD? These are just two of the many common jobs where you'll find it convenient to use a modern tape.

CONTINUED

157



PROTECT A CHROME PART such as this sink faucet with a cushion of masking tape before you tackle it with a wrench. Make the cushion thick enough so the wrench won't bite through.



BOAT BUMPER NEED REPAIR? For this job use a black plastic tape. The tape is strong and waterproof, will stand up under hard wear, and, like other PSTs, will stick at a touch.

SCHOOL INITIALS on a briefcase, in the school's colors, are no trick at all when you choose and use modern plastic tape in colors.



ON THE LEVEL, cloth sewing tape does duty as a ruler. It can be held firmly and invisibly in place with any clear plastic tape.



ON MOVING DAY, use masking tape to secure drawers and cabinet doors while the household goods are in transit to the new home.



are waterproof; others have a tensile strength ranging up to an amazing 500 pounds for one of the inch-wide (and 1/100" thick) glass-fiber filament tapes. Although a tape usually is made for a specific purpose, most will do a variety of jobs.

Paper tapes. Masking tape is the king in this category. Made with a somewhat crinkly crepe-paper back, it is produced in widths from 1/4" up to 3". The crepe-paper back allows for stretch and makes the tape easy to tear. Most masking tape has a moderate tensile strength, around 20 pounds per inch width. Standard color is a natural tan.

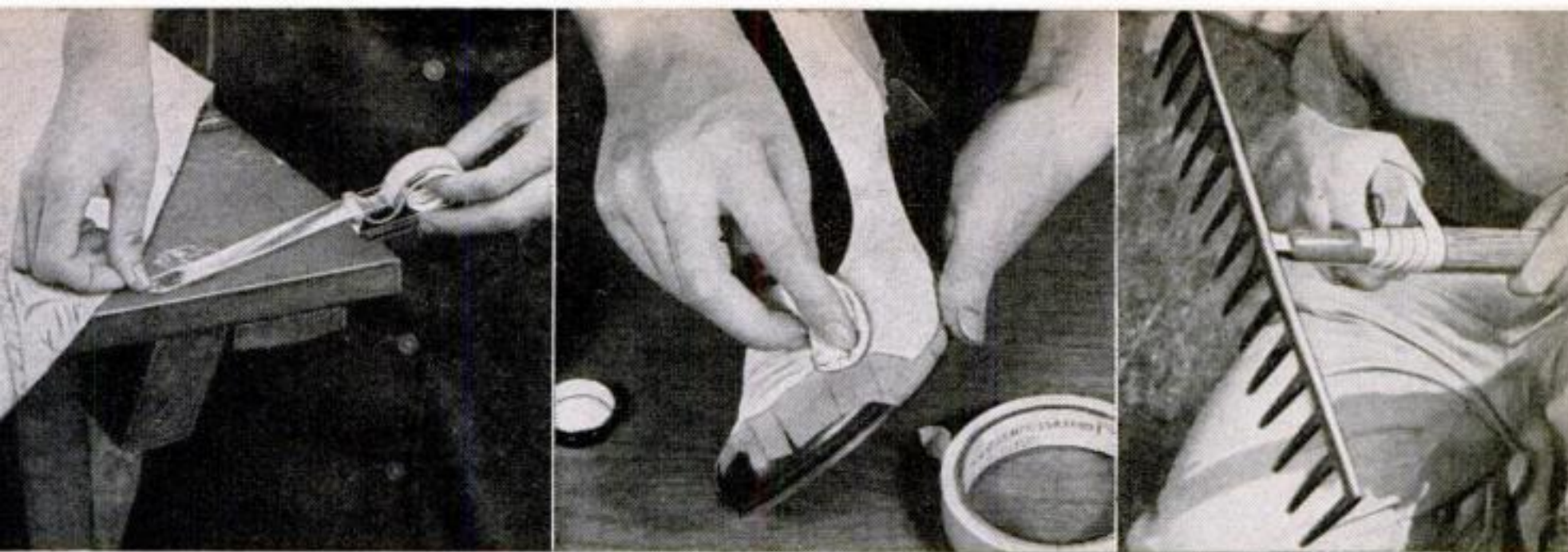
The uses of masking tape are almost endless. Its primary function, from which it derives its name, is to produce a clean edge when you are painting.

Masking tape may also be used to clamp glued parts together, to seal the backs of picture frames, to bind wood parts being sawed, to mend fabrics and materials, to wrap rough or broken tool handles, to hold patterns in place, and to hold drawers shut when you move furniture.

High-temperature masking tape is available for paint jobs that have to be baked.

Closely allied to masking tape are flat-back paper tape, with less stretch and more strength; drafting tape, which will not harm cloth or paper; freezer tape, which sticks tight at low temperatures; and black paper tape, a boon to photographers and dark-room technicians.

Unique among the paper varieties is



ON A WINDY DAY, double-face tape is the thing to reach for to hold down a picnic tablecloth. Use it on paper plates, too.

FOR A TWO-TONE SHINE, use masking tape on shoes to keep the colors from overlapping. The tape will pull away easily.

CRACKED RAKE HANDLE can be reinforced with tape. Mending and grip-reinforcing tool handles are two useful tape jobs.

double-face tape. Coated with adhesive on both sides, this is perfect for mounting snapshots in albums, for making a dark-room easel for photo enlargements, for attaching felt pads to lamp bases, for pasting down art layouts, for holding shelf paper and decorations in place, and for invisible gift wrapping.

A wide (up to 3") paper-carton sealing tape has recently been developed to replace the old wrapping tapes, which must be moistened.

Film tapes. Varicolored, strong, and usually waterproof, these include the well-known cellophane tapes and others that have a backing of plastic cellulose acetate, vinyl, polyethylene, and nylon. They are made in widths ranging from 1/4" to 4", and in such colors as yellow, brown, green, red, blue, white, and black. There are also transparent varieties.

A top performer is black vinyl electrical tape made in 1/2" and 3/4" widths. Its superior qualities have made it the successor to rubber and friction tapes for many kinds of electrical work. You can also use it to insulate tool handles, to patch pipes not under pressure, and to mend garden hose.

Cellophane tape is probably the best known of all PSTs. Like masking tape, it's almost an all-purpose tape. It is used for a host of mending, sealing, patching, and packaging jobs. Made in widths from 1/4" to 1", it also comes in colors, and in this form is tops for gift wrapping.

An ultra-transparent film tape, known as magic mending tape, is practically invisible when used to cover tears in

paper. You can write on it with a pen or a pencil.

There is also a double-face cellophane tape.

Colored plastic tapes are made in widths from 1/4" to 4" and are invaluable to the handyman and the amateur decorator. Use them to repair plastic garden hose, inflatable plastic toys, auto-seat covers, shower curtains, table cloths, raincoats, boots and galoshes, umbrellas, and schoolbook binders.

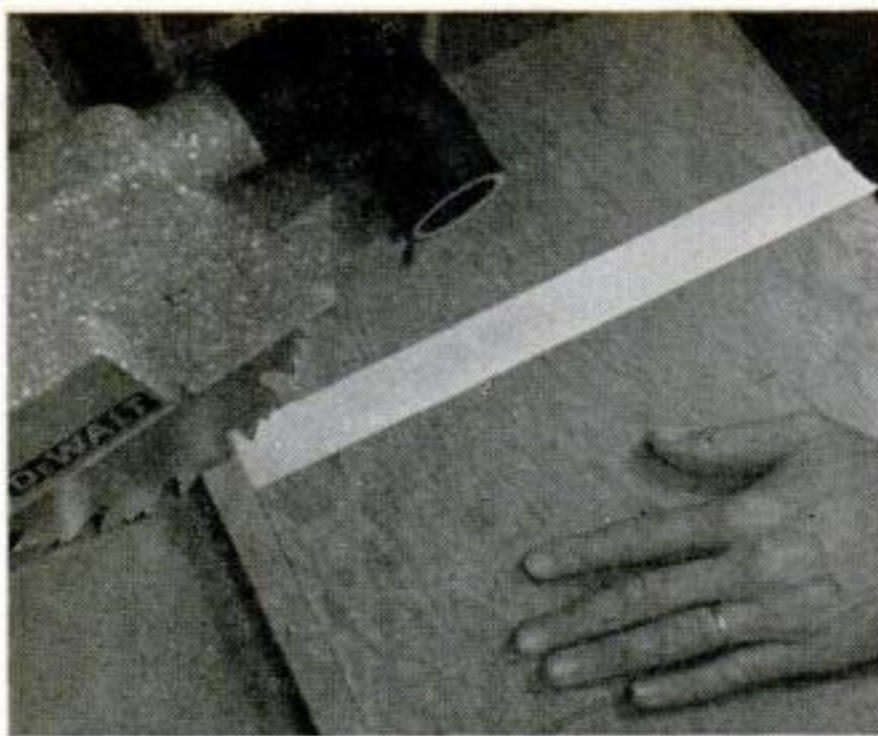
A new nylon-backed "sliding tape," 3/8" wide and slightly thicker than other plastic tapes, is intended to reduce friction when used as a runner on drawer bottoms.

Cloth tapes. Made in practically any width and color you might desire, these tapes have enormous decorative and handicraft possibilities and may also be used for many mending jobs. Some have a plastic coating and are said to be waterproof.

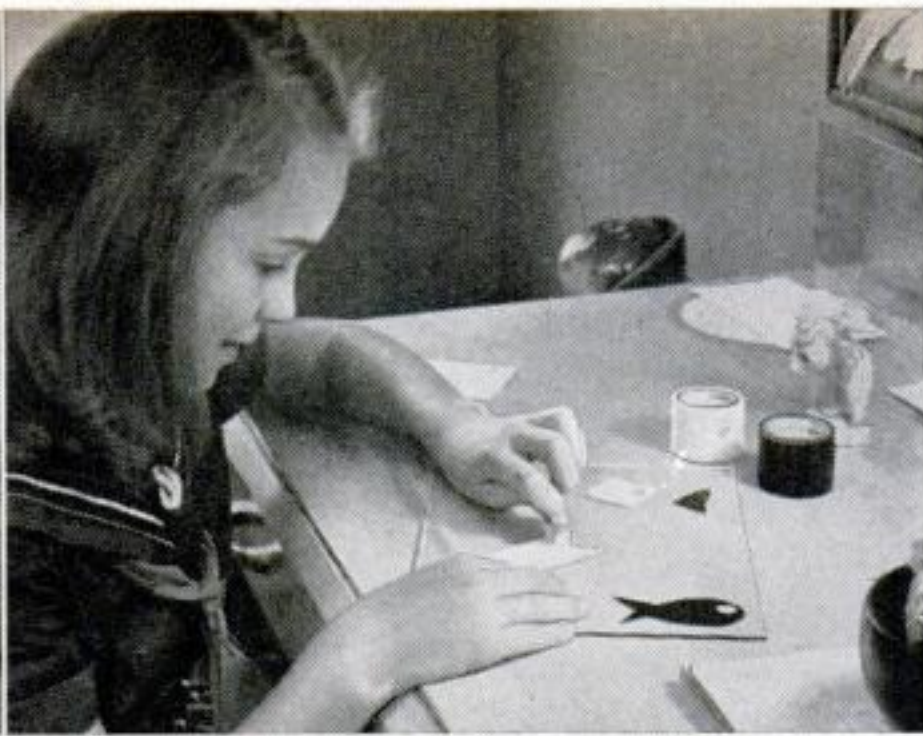
Cloth tape is a good substitute for paint in certain situations—where you want to add color to shelf edges, for instance, or stripe small pieces of furniture.

Use cloth tape to repair fabrics and upholstery, to cover faded tapes on venetian blinds, to mend lamp shades, window shades, and book bindings, to wrap the handles of sports equipment, to repair canvas, and as an invisible weather-stripping.

Filament tapes are the strong boys among the PSTs. Made with a backing of strands of glass, nylon, or rayon, they have the highest tensile strength of any



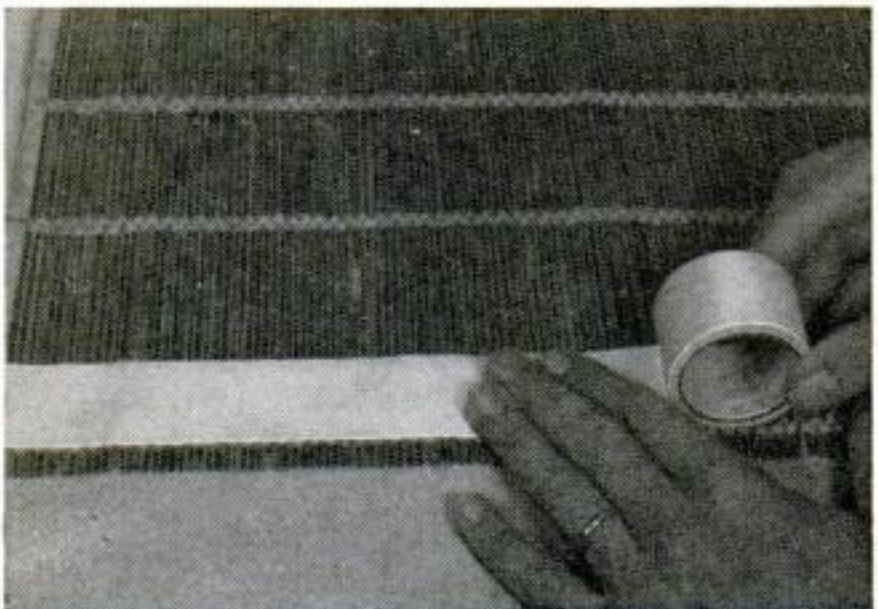
PLYWOOD WON'T SPLINTER at the edge so badly if you take the time to put a strip of masking tape where you plan to make a saw cut.



PLAYTIME FOR THE YOUNGER SET: Colorful plastic tape is just the thing. Decorative shapes cut from it will adhere even to glass.



RUBBER GALOSHES can be reinforced and decorated with plastic tape. Moisture resistance is a characteristic of this kind of tape.



A STRIP OF CLOTH TAPE is being used above to decorate a place mat. The cloth tape can be used to repair any torn or scuffed material.

of the tapes—up to 500 pounds per inch of width.

You could, if you were stuck, actually fashion a car tow chain from one of these tapes. It's been done and it works.

Filament tapes are made in widths from $\frac{1}{4}$ " to 3". Colors include red, black, blue, and white, in addition to the standard transparent type. The glass-fiber variety is the strongest and has the least stretch.

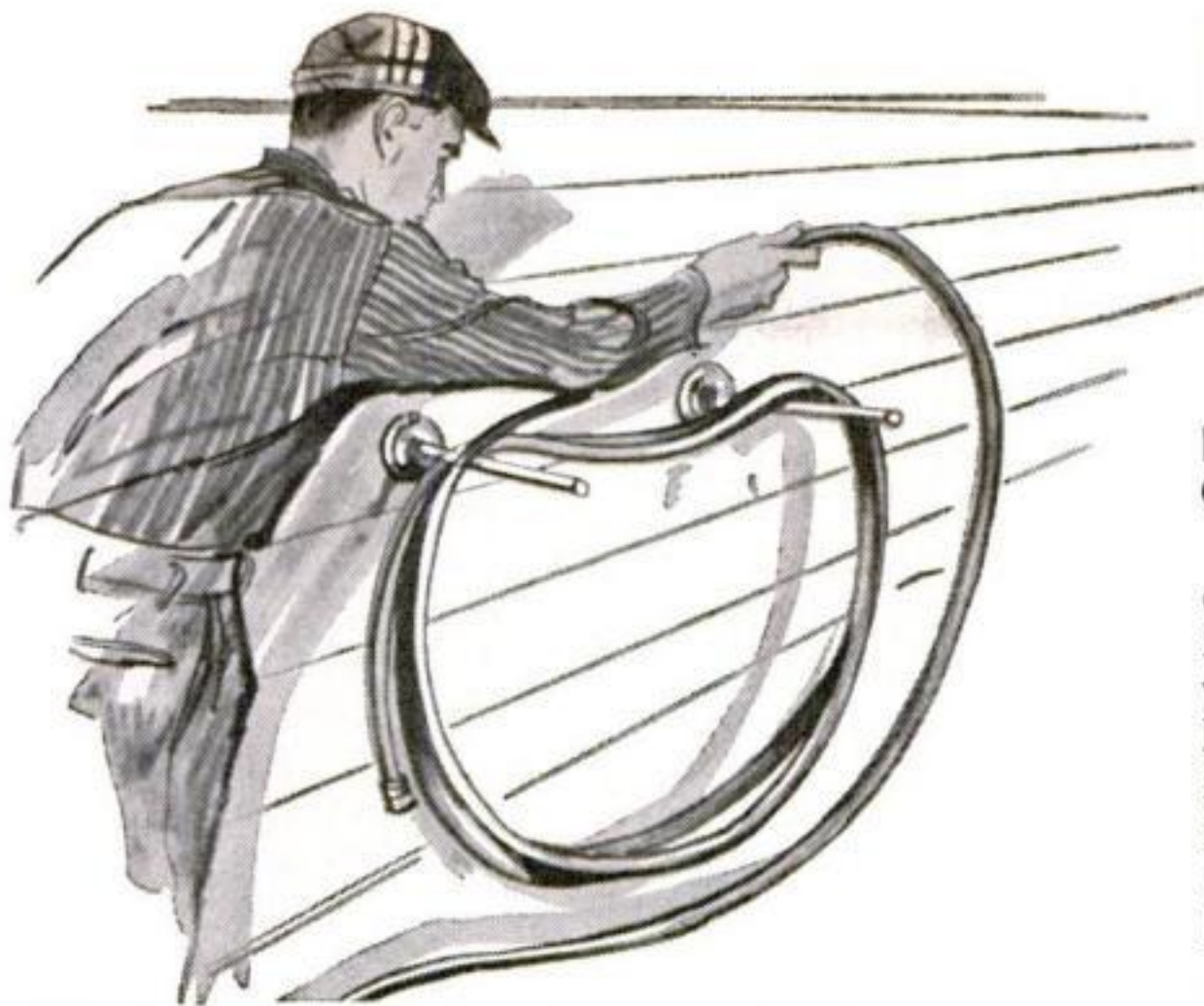
The superb strength of filament tape, sometimes called strap tape, can be harnessed for special jobs around the home and shop. Use it as a heavy-duty glue clamp on odd-shaped objects, to repair broken tool handles and broken furniture, to seal cartons for storage or moving, to bundle up lumber and pipe, and to hold down tarps.

Metal tapes. These special-purpose tapes, much used in industry, are not actually made for the retail trade. If you think nothing else will solve your problem, however, you may be able to wangle a roll through a tape distributor.

Metal tapes are made in two forms, aluminum foil and lead foil, and in $\frac{1}{2}$ " and 1" widths. The unusual composition is the best clue as to how they might serve you. The aluminum-foil tape will join or seal aluminum in any form.

Lead foil, because of its inert status, makes a good bond between unlike metals. Sealing the joints around vent pipes in metal roofs is one of its jobs.

Handicrafters with imagination may be able to achieve unusual decorative effects with it.



Short Cuts and Tips

FROM PS READERS

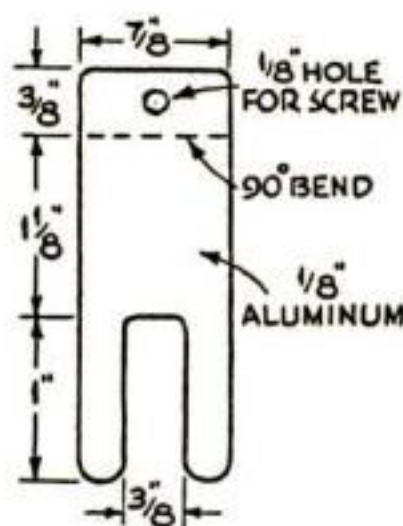
Hanger for Garden Hose

MOUNT two 12" lengths of $\frac{1}{2}$ " pipe in flanges about 2' apart on any suitable wall—on the outside of the house or in the garage, for instance—and you have a neat and handy hanger for your garden hose.—*F. W. Banner, Morrisville, Pa.*



Wax Simplifies Thread Miking

HOLDING three tiny wires against the threads of a screw is a four-handed job when you're trying to measure the diameter with a micrometer. I press the wires into a small can filled with wax, and the wax holds them perfectly. When the wax gets full of holes, I simply remelt it and let it harden again.—*H. J. Gerber, Stillwater, Okla.*



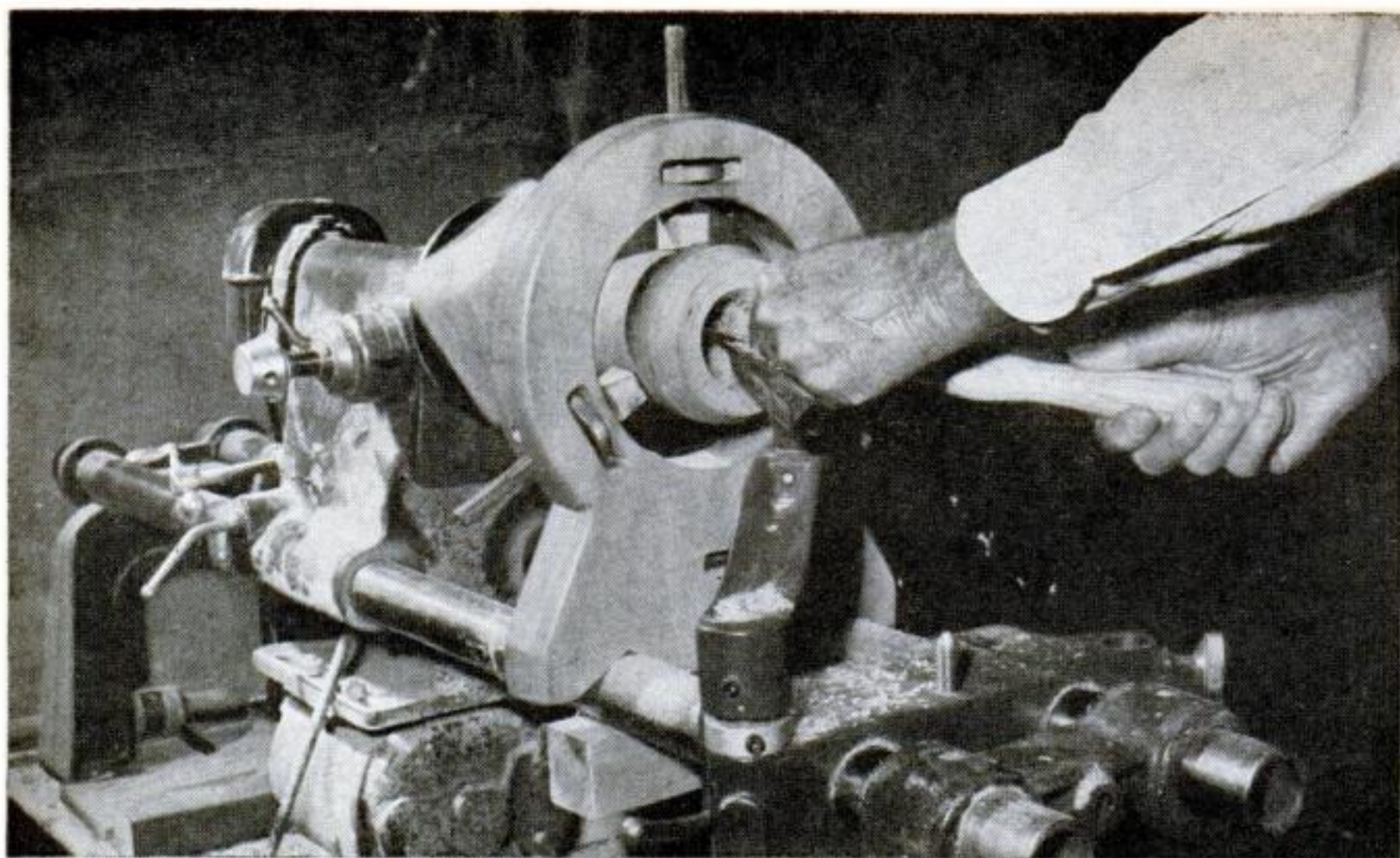
Clip Locks Power Cords

PLUGS on tools, freezers, and other appliances can't accidentally pull loose from wall receptacles with this clip. Cut it from $\frac{1}{8}$ " aluminum, slot one end for the cord, and bend it into a hook to fit over the plug. The screw in the cover plate of the outlet holds the clip on, locking the plug in the socket.—*Herbert G. Eidson Jr., Winston-Salem, N. C.*

Antique Finish from Shoe Polish

TO OBTAIN an antique finish on wood carvings, ordinary shoe polish gives beautiful results. The best colors to use are oxblood and mahogany stain. Rub the polish into the pores with one cloth, then with a clean, soft cloth give it a brisk polish.—*Martin D. Koehler, River Grove, Ill.*





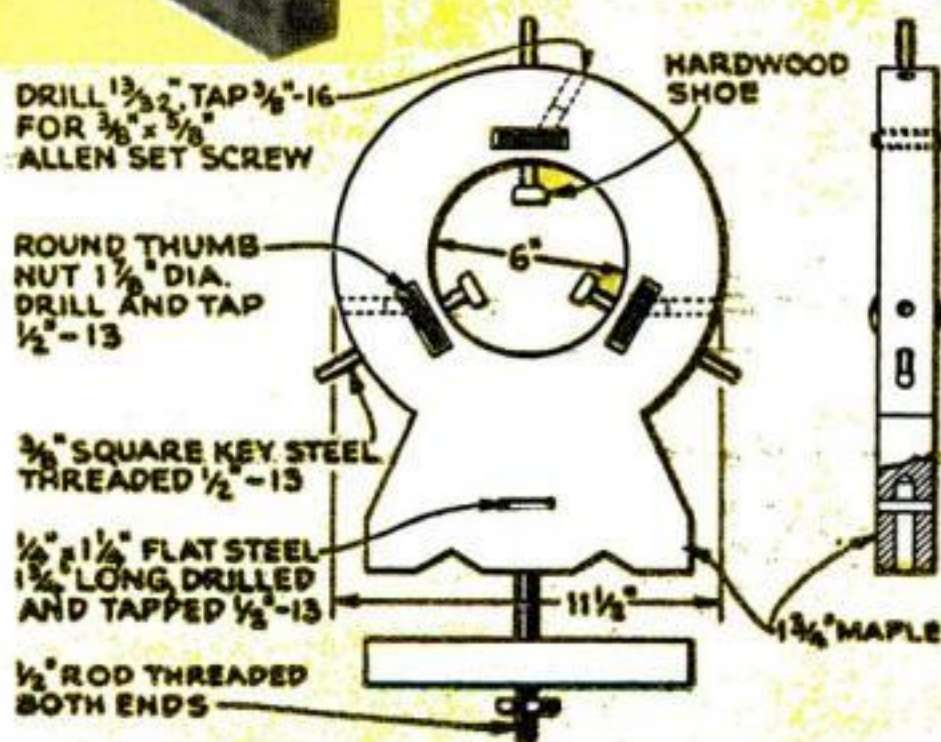
HOW TO MAKE A Steady Rest for a Wood Lathe



A STEADY rest is not a usual accessory for a wood lathe, but the use of one will open up a whole new category of turning projects for you. For instance, you'll be able to turn hollow wood projects, such as flower vases, that are too long to be worked unsupported from the faceplate.

The steady rest shown here can be duplicated for about \$6. It was made to fit a Shopsmith, but the dimensions can be adapted to any wood lathe—or even to a small metal lathe if you wish.

The main body of the rest is made from $1\frac{3}{4}$ " maple. The outside shape is cut on a band- or jig-saw. The inside is rough-sawed $\frac{1}{4}$ " undersize and then bored with the workpiece clamped in place on the lathe. Square holes for the key stock and slots for the thumb nuts are cut with a $\frac{3}{8}$ " mortising bit. Use talcum powder when tapping wood for setscrews.—H. L. Luckett, San Antonio, Tex.





Short Cuts and Tips

FROM PS READERS

Whirling a Pen to Make It Write

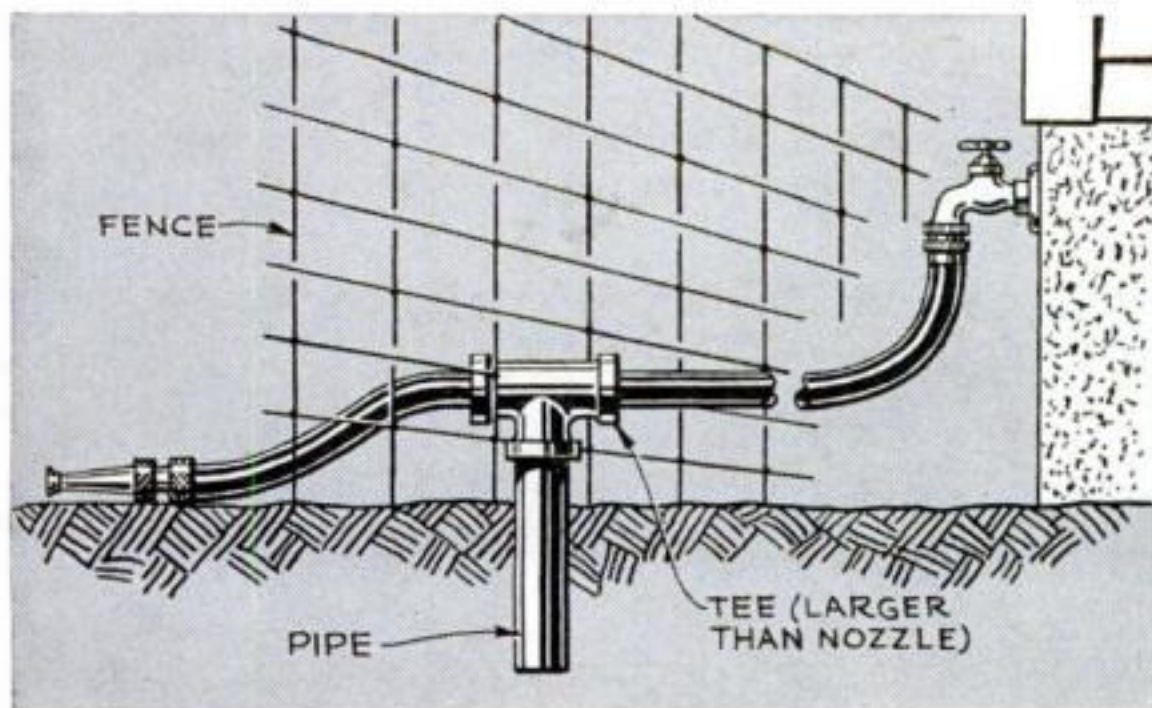
WHEN a ballpoint pen refuses to write, I whirl it on a string with the point outward. The ink usually is driven to the point.—*R. De-
neen, St. Cloud, Minn.*

▶▶▶ To HAUL long pieces of pipe, place them on the ground and straddle with a car. Raise and tie ends to front and rear bumpers.

▶▶▶ WHEN I go under the hood, I like a clean engine to work on. With a 3" paintbrush, I apply a mixture of three cups of household detergent and four of hot water to the engine, battery, fender, and fire-wall. Then I rinse with a garden hose. Afterward, I lift the distributor cap and wipe inside with a clean cloth.—*M/Sgt. W. L. Rivers, Plattsburgh, N. Y.*

Shelf for a Typing Table

To GAIN additional storage space, I made a three-sided bin out of $\frac{3}{8}$ " plywood and inserted it in my typing table. By loosening the stretcher bar at the table bottom it was possible to spread the frame slightly and push the bin into place. A few screws hold it securely.—*Jerry Parker, Sonoma, Calif.*



Tee Protects Garden Hose

A GARDEN hose may become badly worn at a spot where it passes through a woven wire fence, as in my garden. To protect it, I drove a piece of pipe into the ground at the base of the fence and threaded on a tee that's large enough to let the hose nozzle slip through.—*W. C. Wilhite, Carlinville, Ill.*

Good Tricks for Better Power Sanding

By George Daniels

THE rules of power sanders are strict: Rotary sanders cut fast but leave circular marks, so you're not supposed to use them for fine-finish sanding; straight-line sanders cut smoothly but slowly, so you're not supposed to use them for fast, rough work.

You've probably heard these a million times. Yet there are many occasions when you can break the rules if you know the special traits of each type of power sander and the tricks for getting more out of it.

Take a disk sander, for instance. It cuts fast and ferociously. A coarse, flexible disk in an electric drill, turning at 2,400 r.p.m., will grind a picket-fence point on a one-by-two in 70 seconds.

But a disk is temperamental. It works too fast for easy control of its cutting depth. It may skip, slip, and gouge capriciously, and its rotary motion leaves

YOU CAN EVEN SMOOTH GLASS with a reciprocating sander used like this. Set it upside down on a rubber pad to absorb vibrations, and tilt the glass slightly to round the edges.

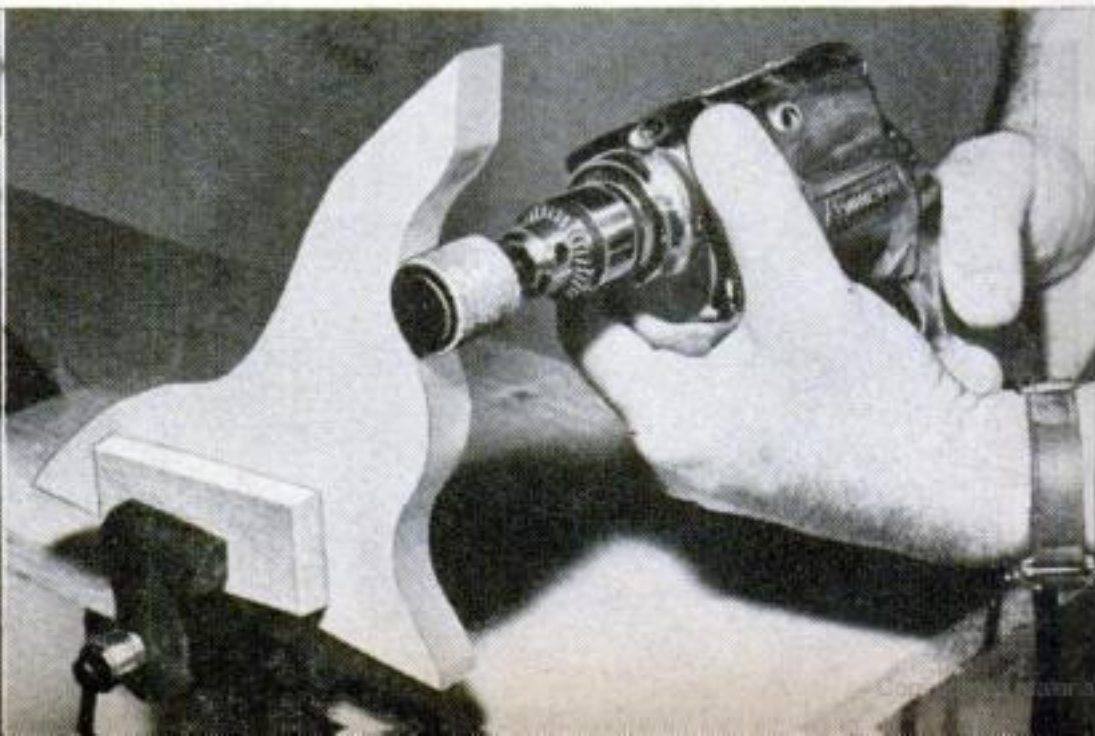


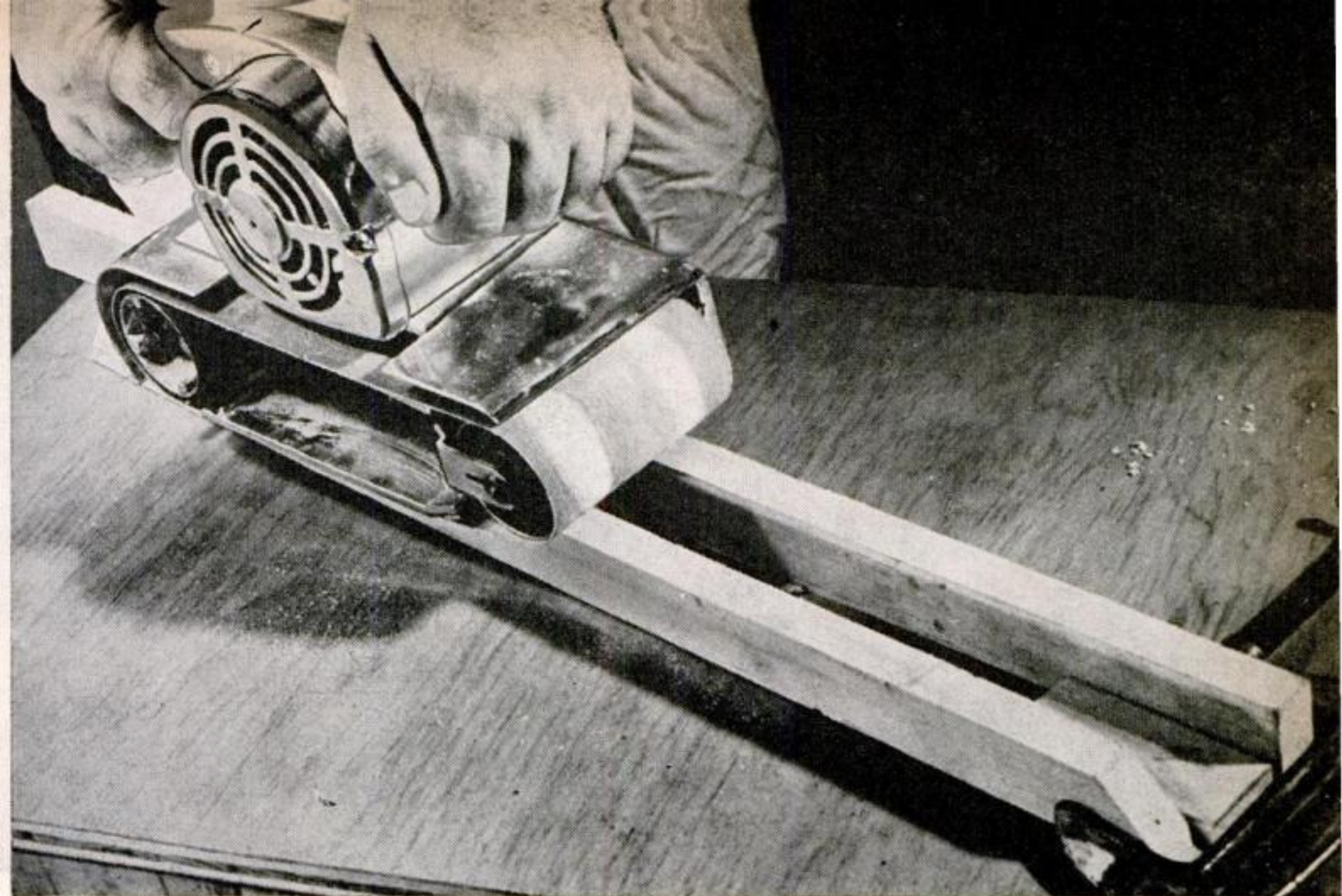
FOR STRAIGHTEST SANDING ACTION from a disk, tilt it so only the outer third touches the work, minimizing swirl marks. Try to develop the one-hand knack shown above. Though awkward at first, it helps you apply smooth, even pressure through a flexible wrist motion.

circular scars. This makes it tops for rough sanding, shaping, and skinning off heavy paint, but not so good for fine finishing. Still, with care, you can overcome its worst objections. There are three tricks to it:

1. Tilt the disk at about a 15-degree angle, so only the outer third touches the work. This way, you get close to straight-

DON'T OVERLOOK YOUR DRILL as an important sanding tool. Besides disks, it will power sanding drums up to 3" in diameter for fast smoothing and shaping of intricate contours.





FOR A SQUARE EDGE on narrow stock when you're using a belt sander, clamp a second strip in place to hold sander level. Belt sanders are top choice for fast, fine finishing.

line cutting action instead of swirls. You also get maximum cutting speed since the outer portion of the disk travels much faster than the center. The faster a sander moves, the smoother it cuts. A 5" disk turning at 2,400 r.p.m. has a rim speed of 3,000 feet a minute. Keep the disk moving in the direction of the grain, never across it, and don't stop in one spot.

A HOMEMADE STAND like this doubles the use of a portable belt sander by turning it into a bench tool. The hose-holding bracket lets you borrow your wife's vacuum cleaner to suck up dust.

2. Don't start with an abrasive grade that's coarser than the surface calls for—this will do more roughing than smoothing. Switch gradually to progressively finer grades, never skipping more than one grit size in the series. This way, each grade smooths away the marks of the preceding one.

3. When you've finished with the finest grade, let muscle power take over. A final touch-up sanding by hand will remove most of the rotary marks.

HIGH-SPEED SANDING in a table saw will cut bevels almost as fast as a router, more smoothly than a saw. This homemade 8" disk cut from $\frac{3}{4}$ " plywood has two advantages: It costs practically nothing, and you can mount a different grade of abrasive paper on each side.



Workshop Chamber of Horrors: Five examples of sloppy work



SWIRLS ARE UNAVOIDABLE with a disk sander, but needn't be this bad. Dark, broken lines above are hit-and-skip marks made because the disk's rim fluttered under too light pressure.

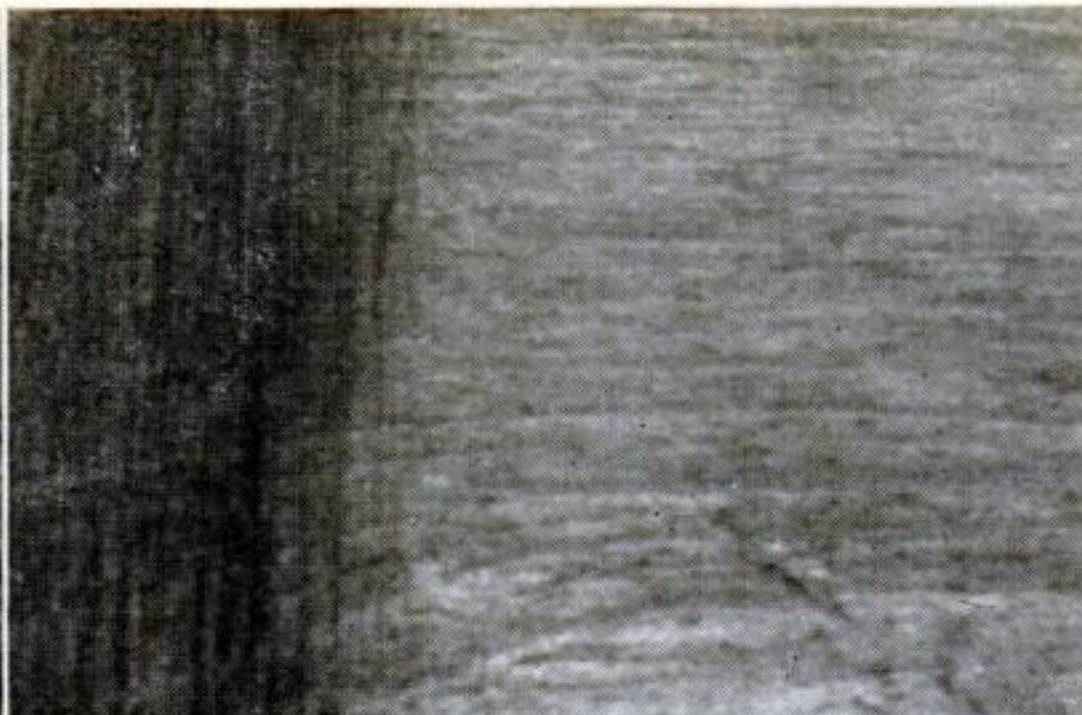
One caution: It's best not to use a disk to smooth plasterboard seams. Any paper coarse enough not to clog may cut right through the board's thin paper facing before you can stop it.

Ball-joint sanders, a recent development, work differently from regular flexible disks. They have a disk that's rigid but freely pivoted so it always lies flat against the work, even when the drill is tipped.

With only a narrow band along the edge of the disk touching the work, you get high cutting speed. The rotary motion does produce some swirls, but the self-leveling action of the pivot eliminates deep scratches and gouges. The best way to use the disk is with light pressure to keep r.p.m. up, overlapping passes to blend them together. It's fine for preliminary sanding, but not for heavy removal or finishing.

Rigid sanding disks can be mounted on a table saw or on the shaft of a separate motor. The metal backing plates sell for about \$5, or you can make your own from plywood.

These work at such high speeds that they give you a shaping tool as well as a smoother. An 8" disk at 3,000 r.p.m. has a rim speed of well over a mile a minute—fast enough to trim off excess stock, shape contours, and cut bevels. On most stock, you use such a small part of the disk that you get the effect of a smooth, straight-line motion. To gain maximum speed, use the outer portion of the disk.



CROSS-GRAIN SANDING makes unsightly marks that are often invisible until you paint or stain. Cross sanding at left above fuzzes the wood so it sops up stain and brings out marks.

When removing a lot of material, take successive light cuts. Heavy cuts will wear off the abrasive particles and tear the paper at the rim.

Reciprocating sanders. Their straight back-and-forth motion at 14,000 or so strokes a minute gives top quality with-the-grain sanding for final-stage work. But it's relatively slow on other stages as the total abrasive travel is only about 150 feet a minute.

The motor-driven models have somewhat longer strokes than the less-expensive vibrator type and cut a little faster. To speed up a reciprocating sander, use it across the grain in the rough stages. It will cut twice as fast this way. Then finish up with a final with-the-grain smoothing. Hard materials cut faster than soft ones because soft surfaces tend to give slightly with the strokes. A reciprocating sander is fine for plasterboard as it takes 20 to 30 seconds before it will cut through.

Orbital sanders have a combined straight and rotary motion that moves the abrasive in tight little orbits, about 3/16" wide at speeds of around 4,600 times a minute. They're medium-fast cutting because they work both across and with the grain at the same time. The circular marks are so tiny that they are generally invisible.

The difference between an orbital and reciprocating sander in the finish you get is not so much quality as appearance. Some pros argue that the reciprocating



TINY SWIRLS like these result when you move an orbital sander too fast or when particles break off and roll around underneath. Move slowly and keep loose grit cleaned away.

sander gives you a more mirrorlike finish, while the orbital type produces more of a matte finish. Other pros prefer the orbital because, in cutting in both directions, it tends to level all the grain equally. Straight-line sanders sometimes remove the soft grain at a faster rate than the hard grain, producing slight surface irregularities.

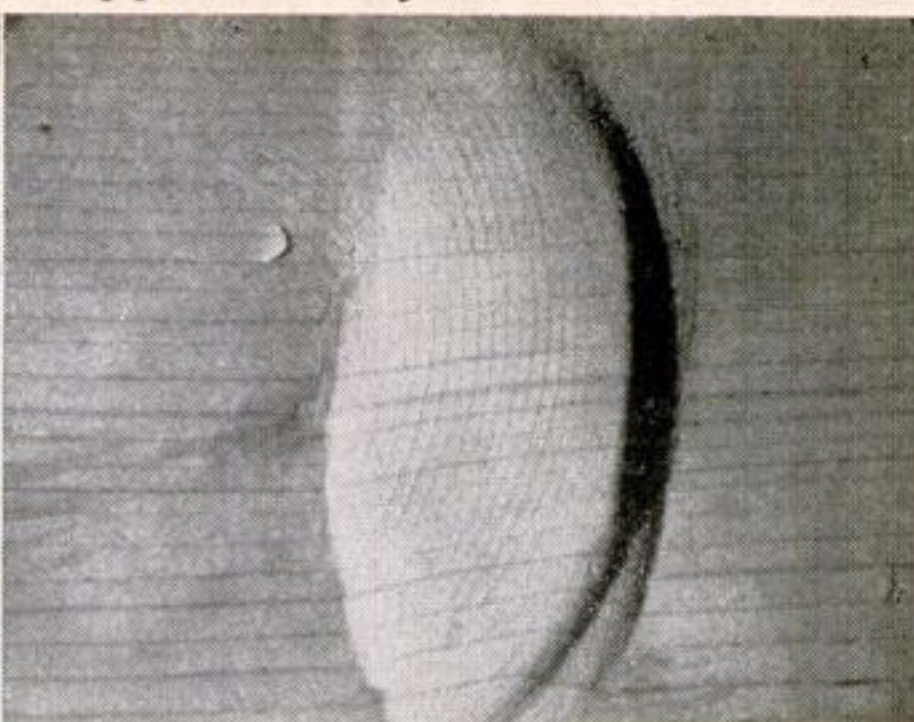
Sometimes loose abrasive particles make scars when they break off and roll around under an orbital sander. Where possible, use abrasive cloth, which retains its particles better than paper.

Drum sanders can be one of the most versatile shaping tools, yet are often overlooked by many who assume they're for use only in a drill press. This isn't true. Drums up to 3" in diameter can be chucked in an electric drill for freehand smoothing of holes and contours.

You can also mount drums in a chuck and arbor on a motor shaft to make a bench sander. By providing a slotted fence or table to limit the drum's cutting depth, you have an accurate edge or surface sander.

The belt sander is a fast worker and cuts a smooth swath. With a coarse grit, it will chew off thickness at an astonishing rate; with fine paper, its straight-line belt motion will give you a satin-smooth cabinet finish in a few passes.

One feature that can be both a help and a hindrance is the lack of any resilient cushioning on the steel backup plate. Instead of conforming to surface irregu-



DEEP GOUGE above shows what can happen when you hold a disk sander in one spot too long. The 1/4"-deep gash was made in 10 seconds with a 20-grit disk at 2,400 r.p.m.



RIM CAKE BUILDS UP when you sand paint or pitchy wood. If not removed, it keeps disk from touching uniformly, producing slow, uneven results. Flex the disk to flake the cake off.

larities, the hard-backed belt tends to level everything in its path. This is fine for surfacing uneven stock, but sometimes makes it difficult to sand out blemishes that lie in depressions.

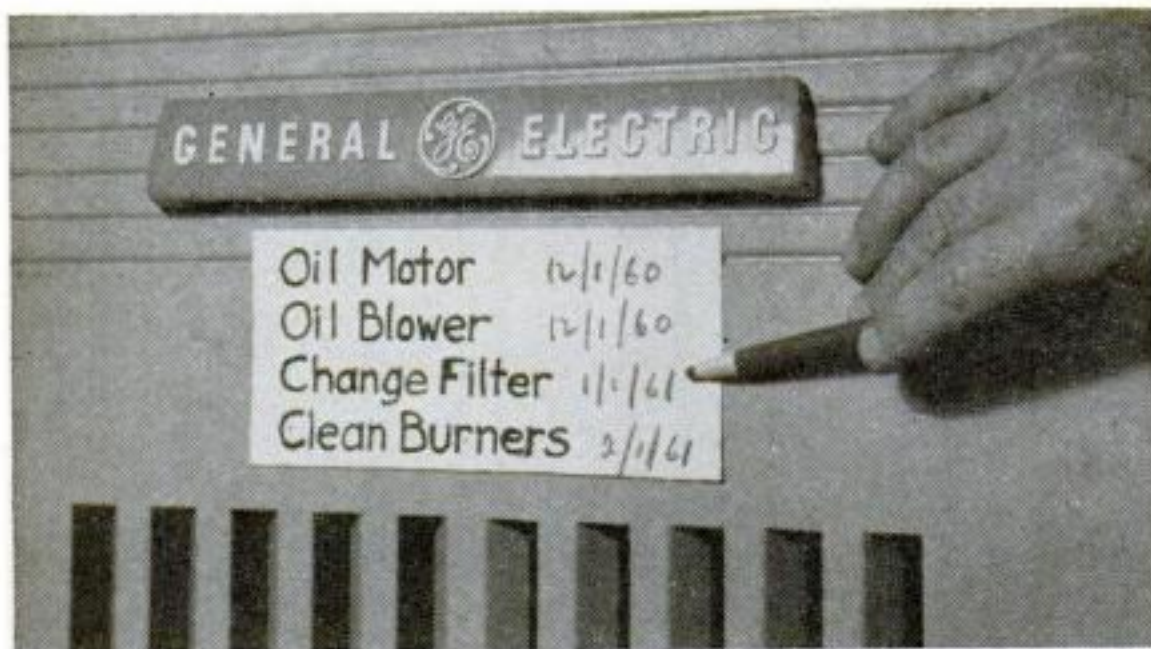
One useful trick on cupped boards is to move the sander along at a 45-degree angle to the grain so the belt rides the high edges and cuts them down. Usually one pass in each direction and a final one with the grain will put a cabinet-grade surface on once-useless lumber. For top speed in rough sanding, you can run the tool across the grain—but watch out for split-outs at the edges.

Short Cuts and Tips

FROM PS READERS

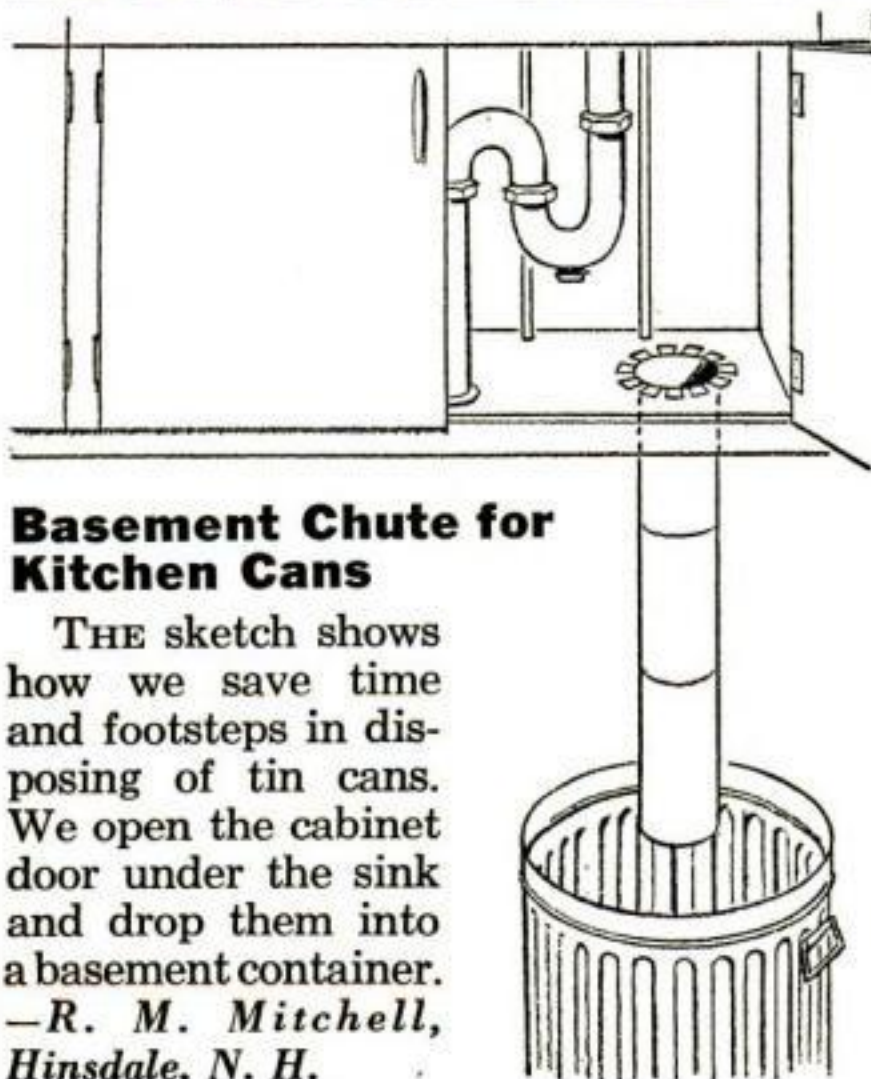
Headlight for Dark Corner

A TELEVISION or radio repairman has both hands free for work if he wears an electric lamp strapped to his forehead as a coal miner does. I have found that it's especially useful for working on a TV in a dark corner.—*Philip A. Farino, Chicago.*



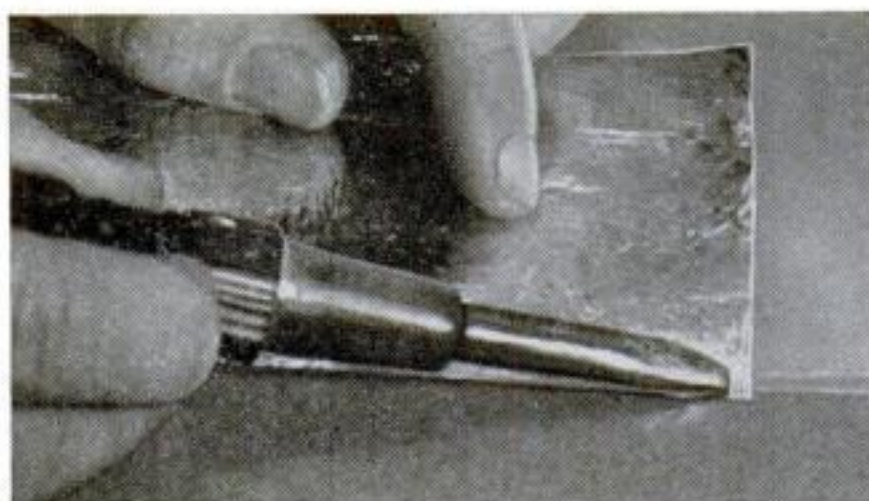
Maintenance List Safeguards Heater

BECAUSE the heating plant is the most important mechanical unit in the average home, it ought to be maintained with care. As a reminder of what should be done at intervals, I have taped a check card to the front of mine as you see in the photo.—*Robert Hertzberg, Douglaston, N. Y.*



Basement Chute for Kitchen Cans

THE sketch shows how we save time and footsteps in disposing of tin cans. We open the cabinet door under the sink and drop them into a basement container.—*R. M. Mitchell, Hinsdale, N. H.*



How to Weld Sheet Plastic

TEARS in plastic raincoats, auto-seat covers, swimming pools, and other sheet products can be repaired with a welded seam. Separate sheets can be joined the same way. Place aluminum foil on each side of the overlap and run a hot soldering iron quickly along it in one stroke. The foil—which can be re-used—prevents burning, helps distribute heat to fuse the plastic.—*Robert Micals, Freehold, N. J.*

Body contouring and a clever tilt design give you all-position comfort in a—

Modern Lounge Chair for \$15



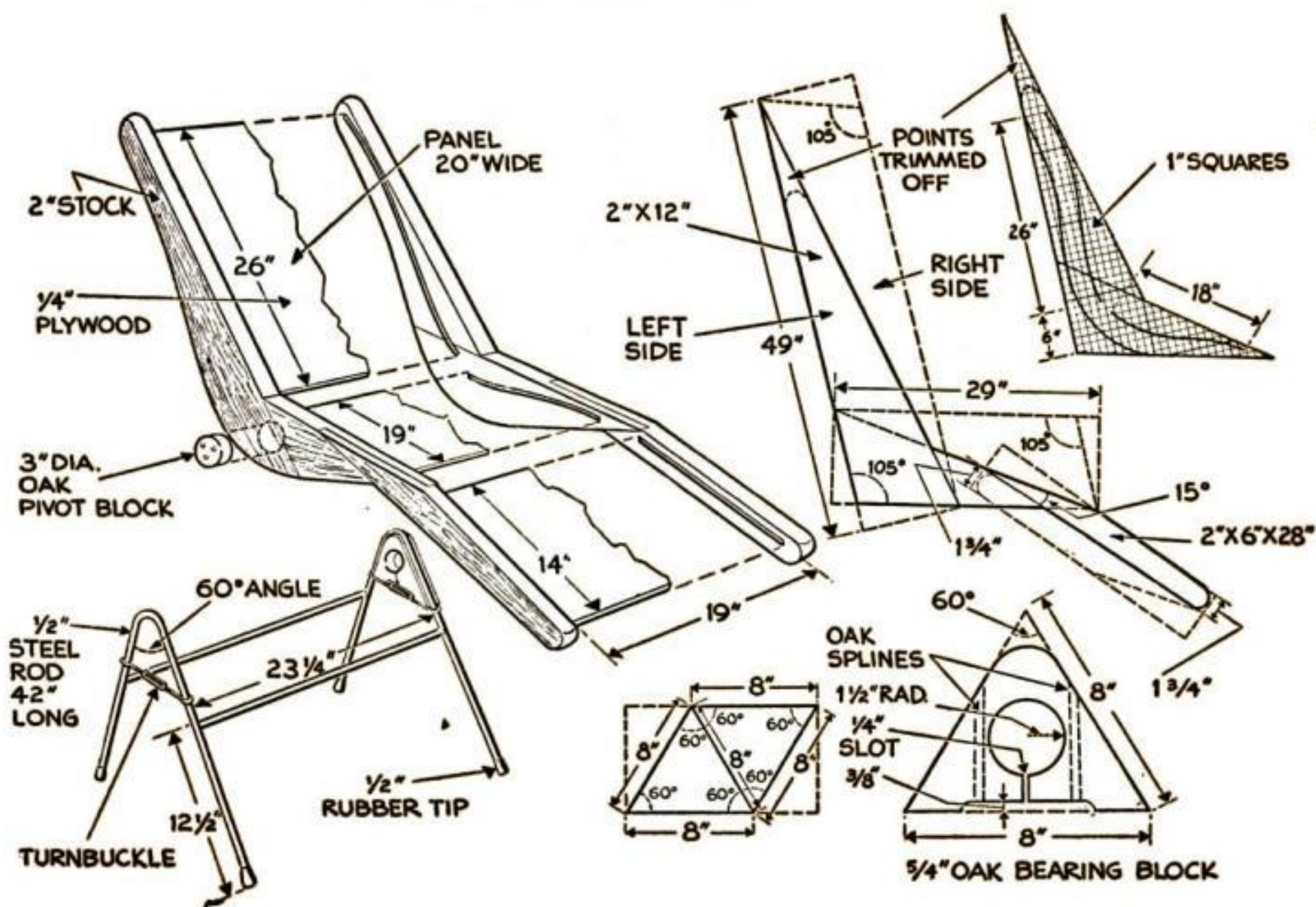
By Paul Corey

SLICK carpentry makes possible this unusual reclining chair. With its trim design, it takes up little more space than an ordinary chair, yet gives you full-length comfort in any position from sitting to reclining.

The secret lies in forming the chair's

side frames with half-lap joints so big and sturdy that they amount to a laminated construction. This tremendous strength permits the frame to be slimmed down to give the delicate lines of finely crafted furniture. Total cost: less than \$15 worth of ordinary materials put together in an un-ordinary way.

A single pivot point permits the chair



CONTINUED

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to tilt forward or back to any angle. A tightening device on the pivot bearing enables you to adjust the tension to the precise point where the chair can be shifted easily with the weight of your body, and yet remains fixed in any desired position.

Laying out the parts. The side frames are easy to cut because each matching pair for the back, seat, and leg rest is sliced out of one piece of wood—you automatically get duplicate parts with no waste.

The two side pieces for the back are made by sawing a 49" length of two-by-twelve lumber diagonally from corner to corner, as shown in the drawing. The parts for the seat come out of a 29" length of two-by-twelve in the same way. A 28" length of two-by-six, ripped down the middle at a slight angle, produces the two tapered pieces for the leg rest.

If you prefer hardwood for the frames, the design is so sturdy that standard 5/4" stock—usually 1 1/8" actual thickness—is strong enough.

Making the half-laps. These are whopping-big joints, but not as terrifying to cut as they may seem. A dado blade or router will do the job quickly. You can also use a handsaw, slicing each piece edgewise and removing half the thickness to form the lap.

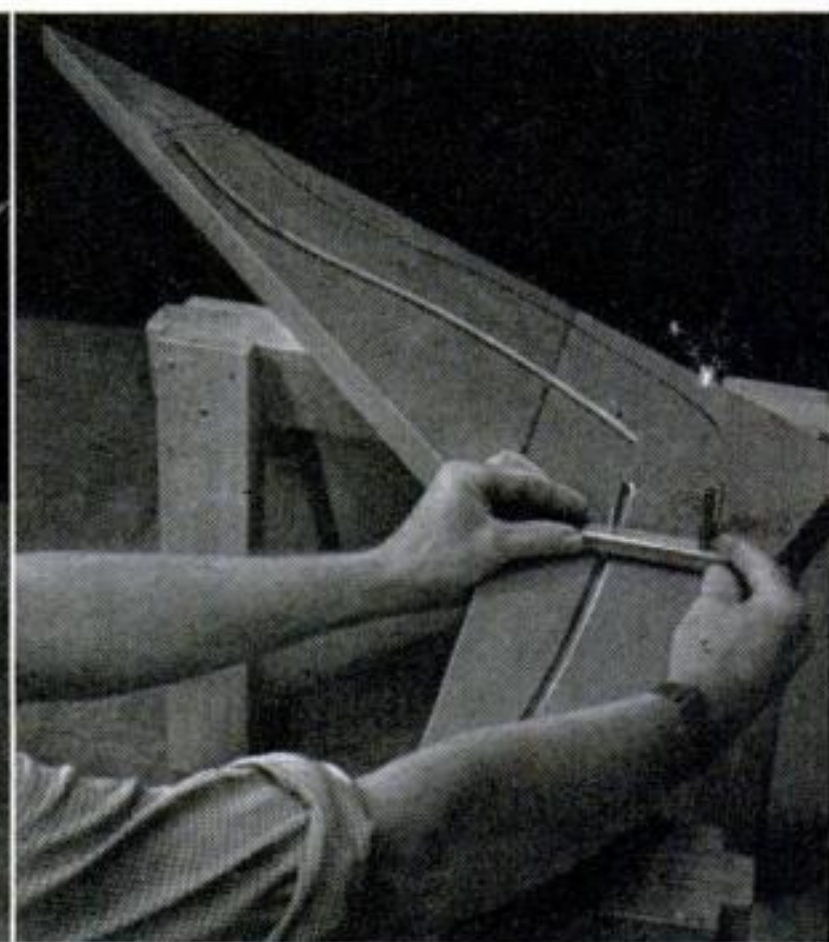
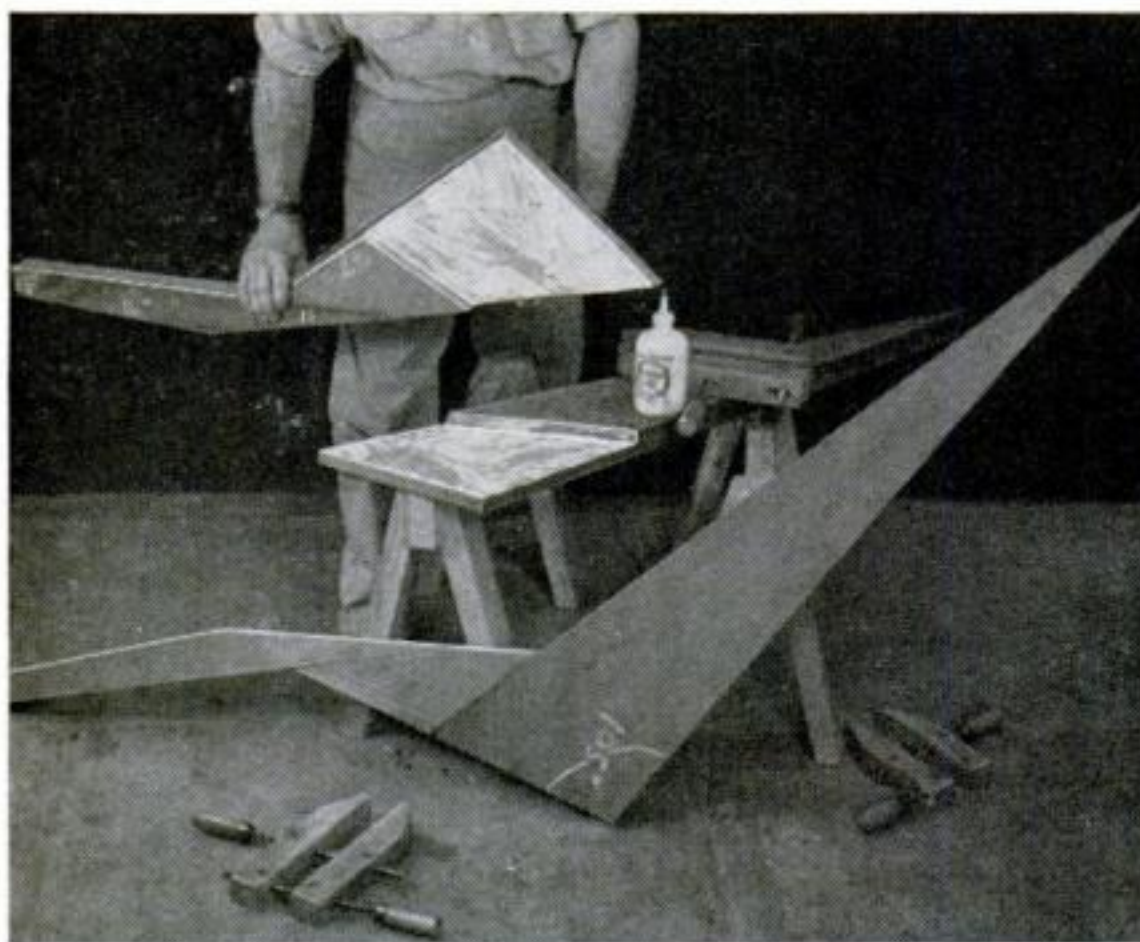
The angles at which the half-laps meet

are determined as shown in the drawing, and the pieces are glued and clamped. The chair's back, seat, and leg support are three separate panels of 1/4" plywood 20" wide. These fit into 1/4"-by-1/2" grooves in each side frame.

Templates for the S-curved grooves can be cut from strips of cardboard marked off in 1" squares. The grooves can be made with a router bit or by drilling a series of overlapping 1/4" holes and chiseling out the waste by hand. The lower grooves for the leg rest are straight and do not require a template.

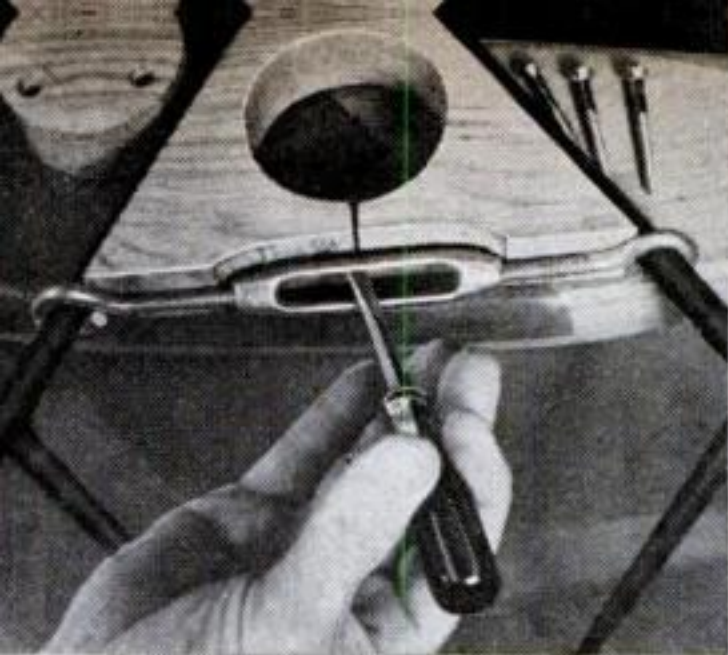
The contour line along the back and lower edges of the side frames is an exact copy of the curves formed by the grooves, but located 2 1/2" beyond the grooves. You can establish this shape quickly by running a drawing compass or homemade pencil-holding jig along the grooves to mark the corresponding contour line on the outer edge of the wood. When the side frames have been completed, the 1/4"-plywood panels are glued into the grooves by springing them slightly and snapping them into place.

Shaping the legs. Two 42" lengths of 1/2" steel rod are bent in the middle to a 60-degree angle to form the two A-shaped leg frames. The bearing blocks for the pivots are best made of hardwood, such as 5/4" oak. These are cut to form rounded triangles that fit the leg angles.

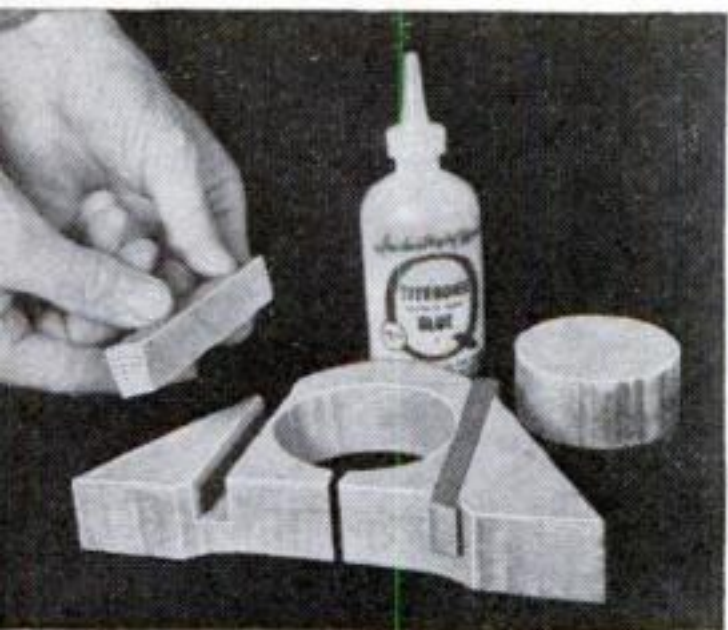


OVERSIZE HALF-LAP JOINTS are the secret of the chair's strength, permitting slim yet sturdy side frames. Glued and clamped, the joints need no screws to hold them together.

REAR CONTOUR OF CHAIR matches the curved seat grooves. You can mark it by tracing the grooves with a homemade compass—a stick with a nail at one end and a pencil at the other.



SPLIT-RING BEARINGS let you adjust the tilting mechanism so the chair balances at any angle. Turnbuckle squeezes the rings to vary pressure on the round pivot blocks.



HARDWOOD SPLINES $\frac{1}{2}$ " wide by $\frac{3}{4}$ " thick are glued into dados cut in the back side of each pivot bearing. These stiffen the bearings so they won't split when they're squeezed.

The contoured seat and back are shaped to fit the body comfortably

THIN PLYWOOD PANELS, easily bent, are the key to the chair's relaxing design. The panels are glued into S-curved grooves in the side frames to form the body-fitting seat and back.



A $\frac{1}{4}$ " slot in the bottom of each bearing block permits the blocks to be squeezed up tight around the pivots on the chair frame. To keep the blocks from splitting when they're squeezed, the sides are grooved across the grain on each side of the center hole to take $\frac{1}{2}$ "-by- $\frac{3}{4}$ " oak splines that serve as stiffeners.

The bearing blocks are wedged inside the steel-rod A frames and held tight by turnbuckles hooked around the rod. The eyes in the turnbuckles are opened first to let them slip over the rod, then bent closed. A recess in the bottom of each block enables you to tighten or loosen the turnbuckles to adjust proper tension. Have the two cross rods that join the A frames welded in place before installing the bearings.

The location of the circular pivot blocks on the chair's frame depends on your own

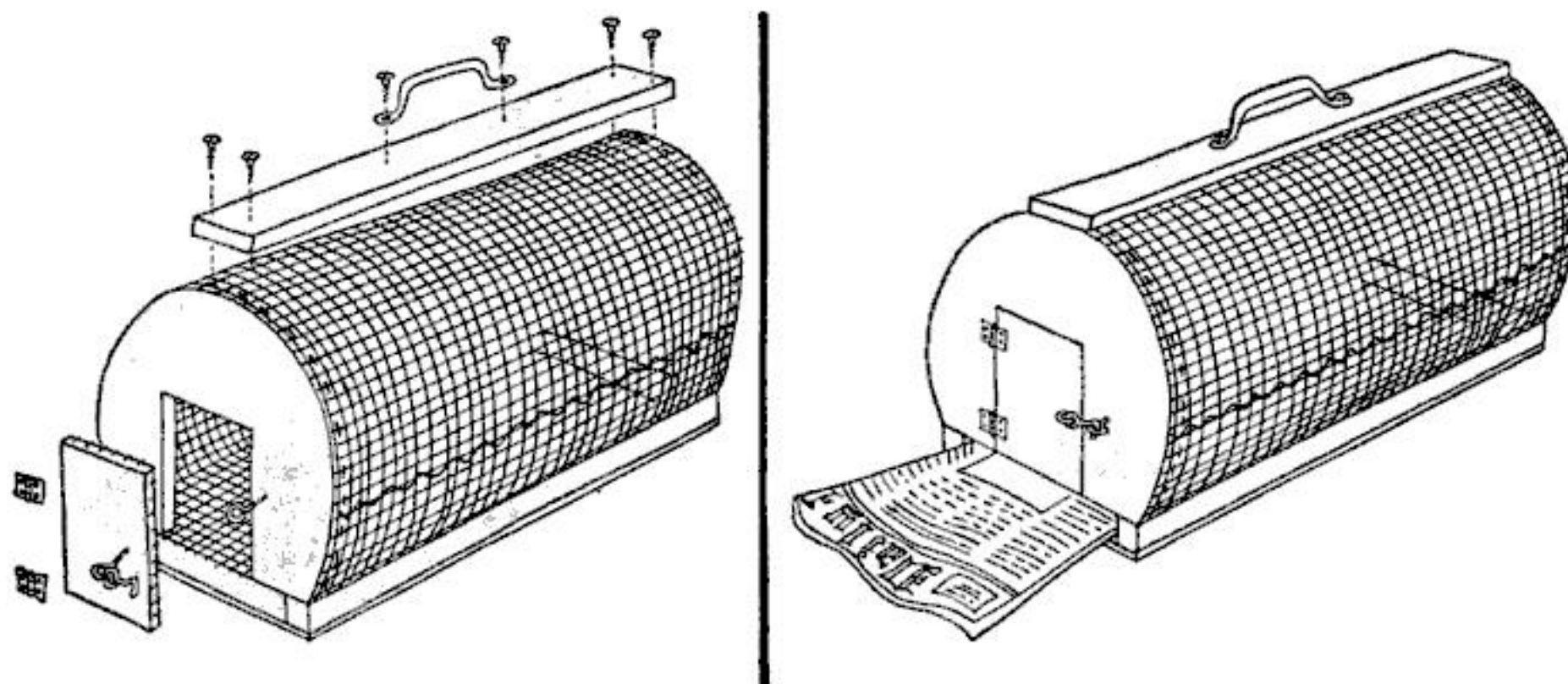
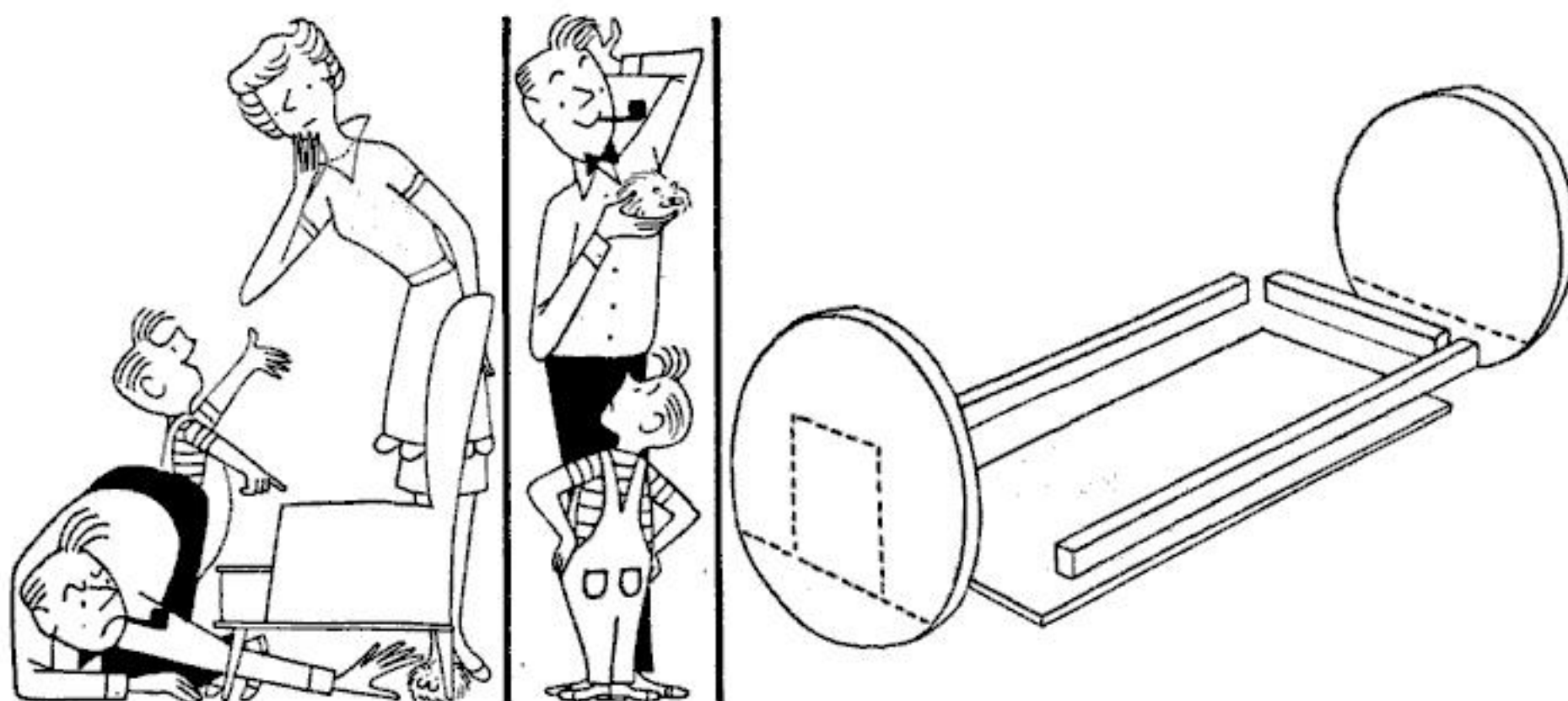
personal center of gravity. For persons of average height, they should be spotted $2\frac{1}{2}$ " to 3" forward of the point where the seat and back meet. Taller persons may want them set even farther forward. It's best to experiment before screwing them completely into place.

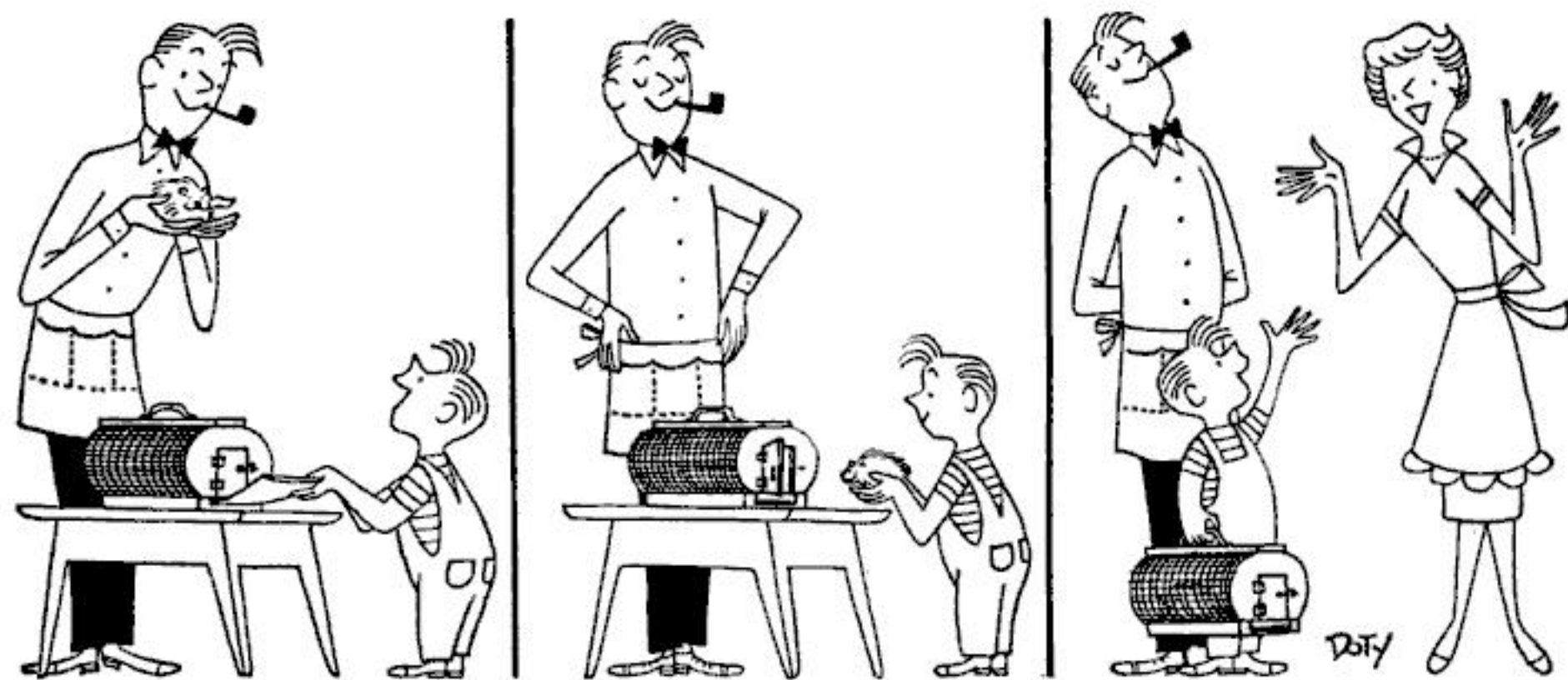
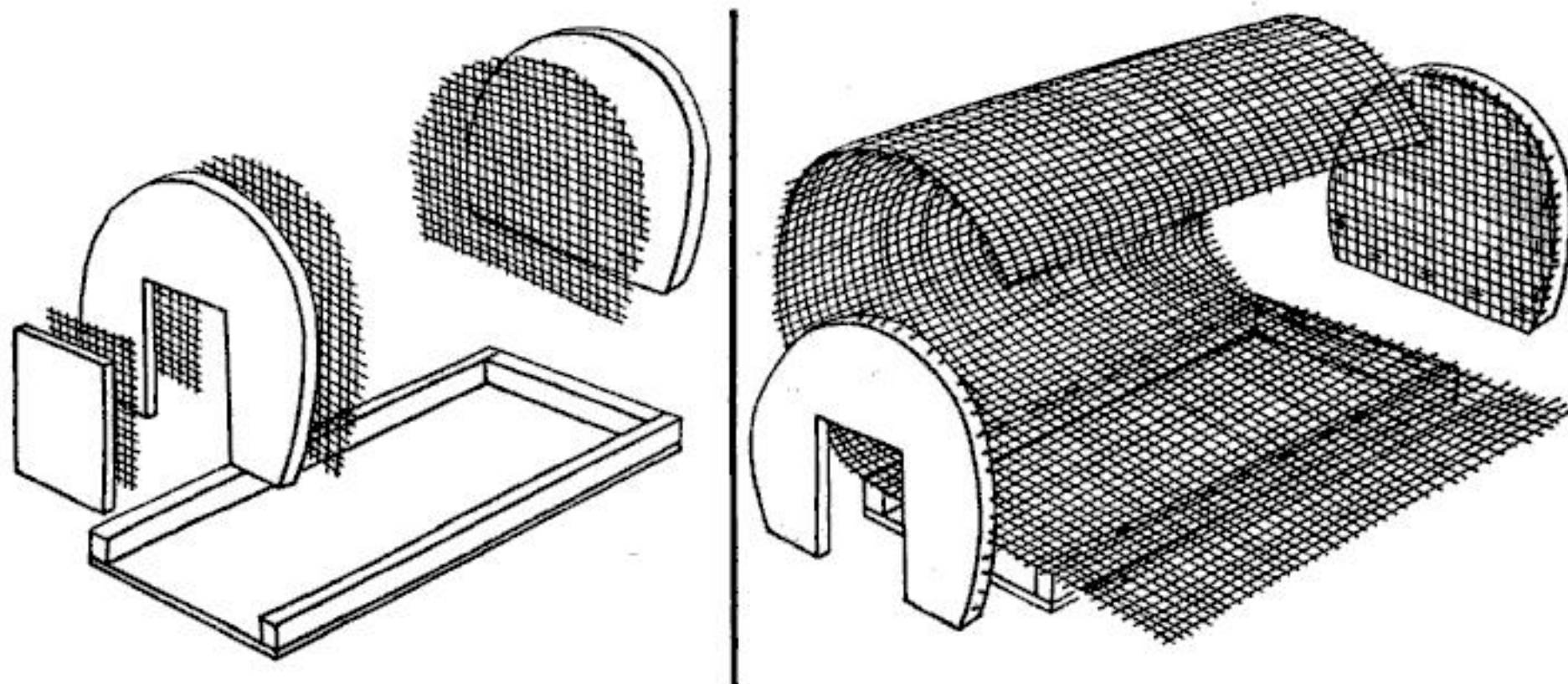
Upholstering the chair. The plywood seat, back, and leg panels are padded with strips of 1"-thick foam rubber. The strips are the same length as each plywood panel, but are cut $\frac{1}{2}$ " narrower at each side.

Colorful plastic upholstery material is wrapped around the foam rubber and tucked underneath at the sides. At the ends, the plastic material is carried around the edges of the plywood panels and stapled underneath. The chair's wood frame is given a natural finish, and the metal legs are painted flat black.

Wordless Workshop

By Roy Doty
and Hubert Lockett





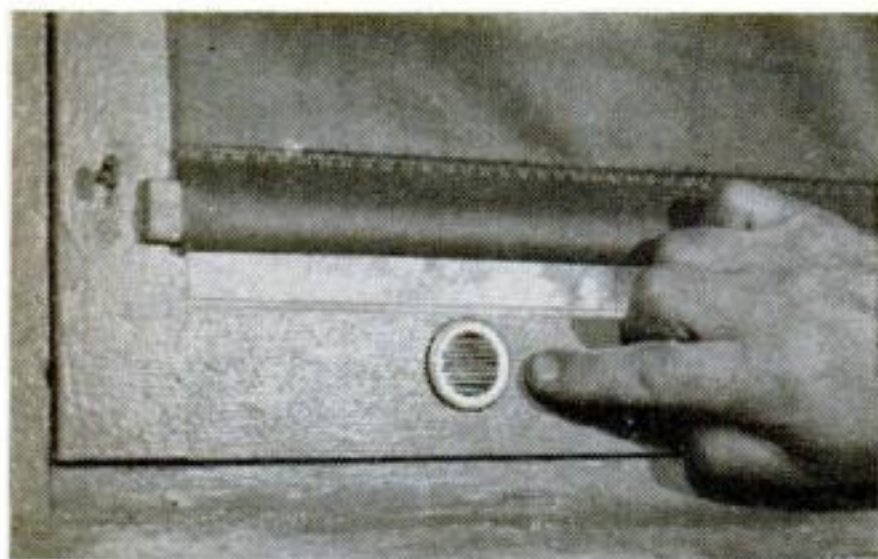
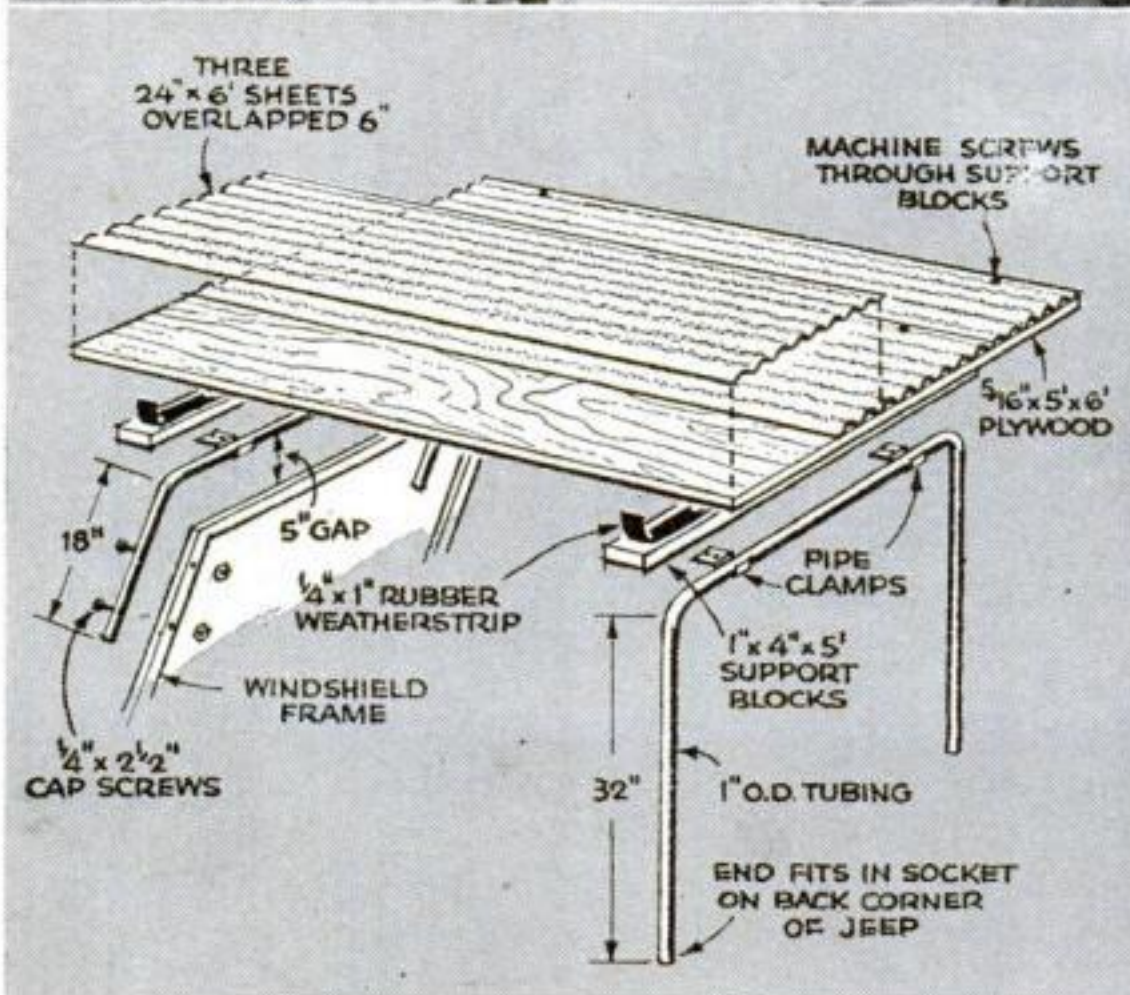
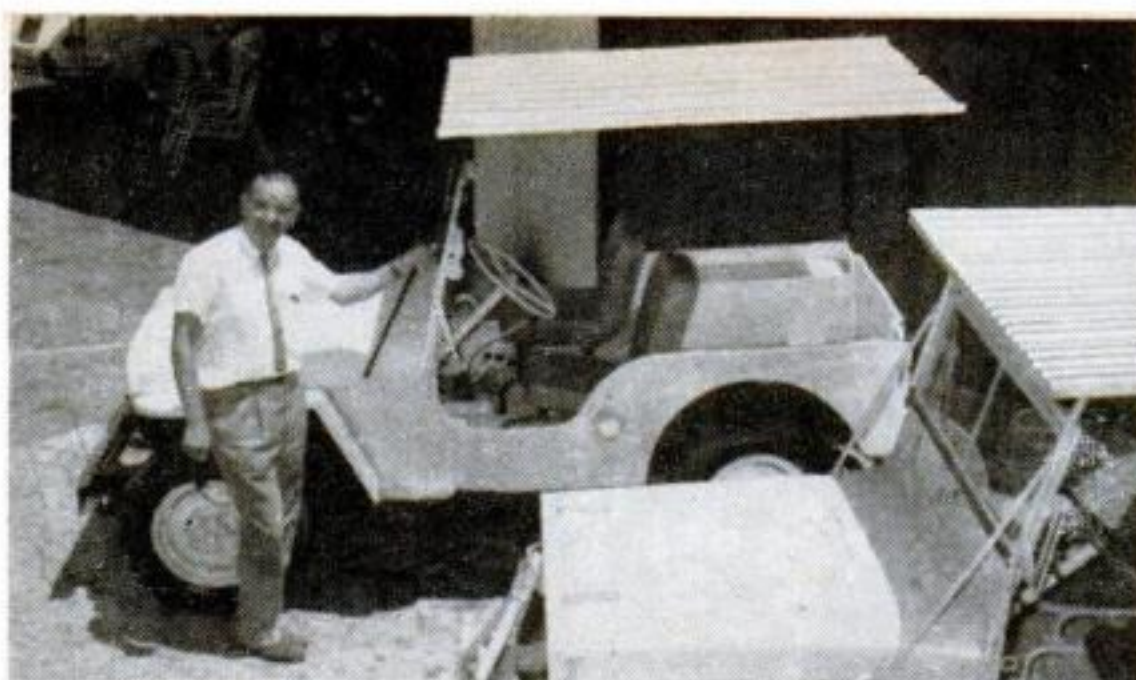
Short Cuts and Tips

FROM PS READERS

Permanent Sun Roof for Desert Jeeps

FOR some years, I've been prospecting the Southwest's deserts. When my Jeep's canvas top gave out, I replaced it with a canopy of corrugated aluminum. This reflects up to 85 percent of the sun's heat, and the plywood beneath stops radiant heat. Braces in front of the windshield add support. They are 28" pieces of $\frac{1}{2}$ " tubing bolted between frame and pivoting arm of the windshield. Now I keep cool at 160 degrees.—Noel R. Kirk, Hollywood, Calif.

▶▶▶ WHEN you find it necessary to slot a strip of thin metal lengthwise, band the strip around a piece of curved wood, place it in a vise, and cut the slot with a hacksaw.—E. L. Enochs, Modesto, Calif.



Breathers for the Furnace

WHEN you weatherstrip basement windows, bear in mind that furnaces require a supply of air. I provided it by boring 1" holes in the window nearest the burner and pushing in small round louvers, the kind made for condensation control by ventilation of outside walls. Hardware stores sell the louvers in boxes of 10.—R. Hertzberg, Douglaston, N. Y.

▶▶▶ SCENIC wallpaper can be cut to size and used as a picture. We pasted a scene on the wall and framed it with molding strips screwed to the wall. A coat of clear varnish gives the paper an antique finish.—Joanne Vosburg, Syracuse, N. Y.



Line Goes Up and Down Fast

BY ATTACHING a screen-door hook on each end of an indoor clothesline, you can put it up and take it down in a jiffy. Put screw-eyes where you'll fasten it.—Wayne Floyd, Fayetteville, Tenn.

The man says:

It's a Son-of-a-Turkey

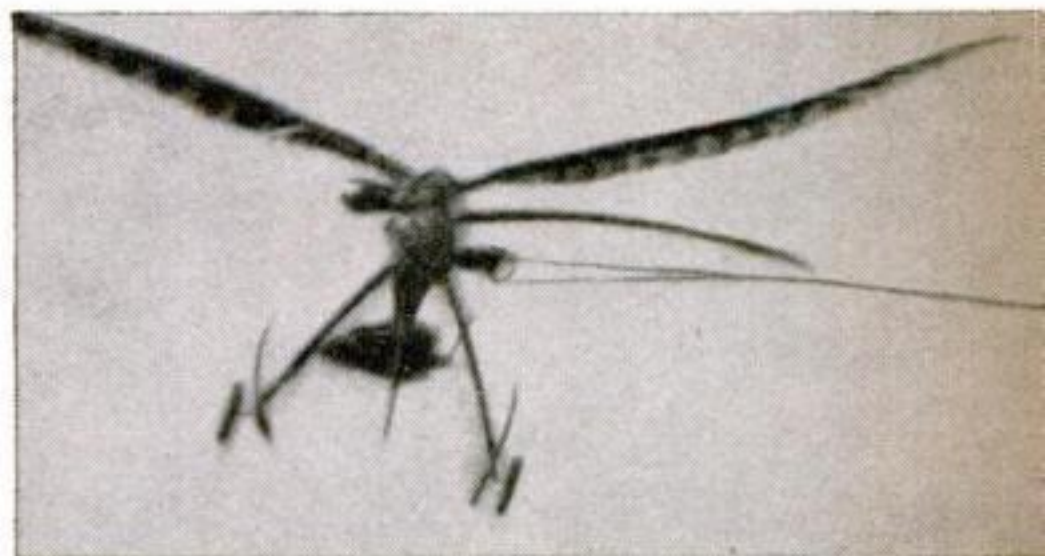
Why bother gluing up wings for a control-line plane when turkey feathers work so well?

WHAT kind of wing can lift 40 times its weight? A wing of turkey feathers—and it's nearly crashproof.

The two feather parts that make up the wing of my Son-of-a-Turkey U-control model weigh one-tenth of an ounce. The weight of the plane is four ounces. In most models the wing lifts no more than 10 times its own weight. And even then the wing is a weak spot. Feathers almost never break.

How can feathers lift so much? Because of built-in camber (curvature control). When the work of lifting makes the quill bend up, camber increases and throws air down faster. This is like putting down the flaps on an airplane to increase lift.

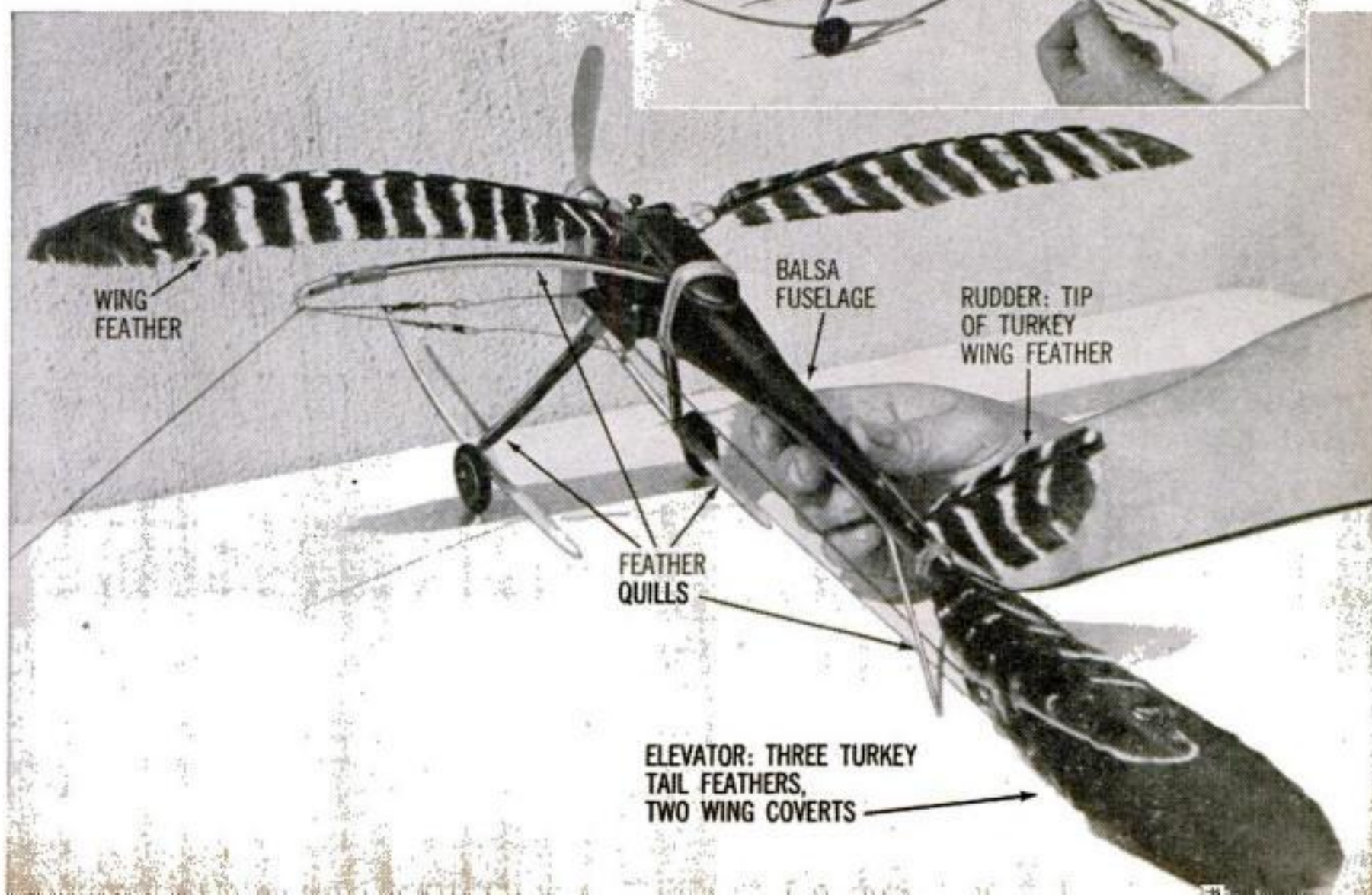
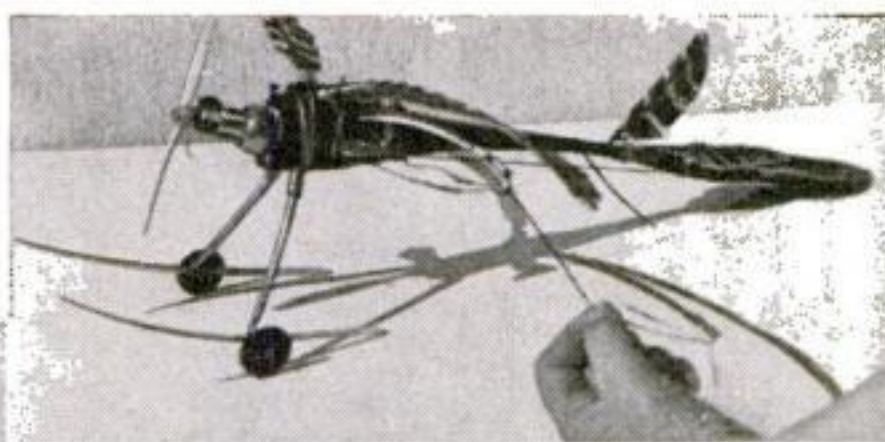
The Son-of-a-Turkey cruises at 25 m.p.h. The wing can stand more than 40



m.p.h. without damage, even during violent maneuvers. The plane climbs well, pulls out of dives, and even glides a little when the engine runs out of fuel.

The feather plane is an excellent trainer for U-control pilots. They can make the plane climb, dive, or loop while it flies in a circle. A U-shaped handle moves the elevators. The long tail prevents overcontrol—a beginner's headache. The quill landing gear can take hard bumps. A quill boom supports the control lines because of wing flex in flight.—
Dudley S. Lynch, Sunnyvale, Calif.

WINGS CURVE DOWN normally but straighten out in flight. The feathers chosen as wings were the fourth from the leading edge of a turkey's wings. The elevator hinge is covered by a covert feather. Engine is a .049 Thimble-Drome Babe Bee fitted with a nylon propeller.



Short Cuts and Tips

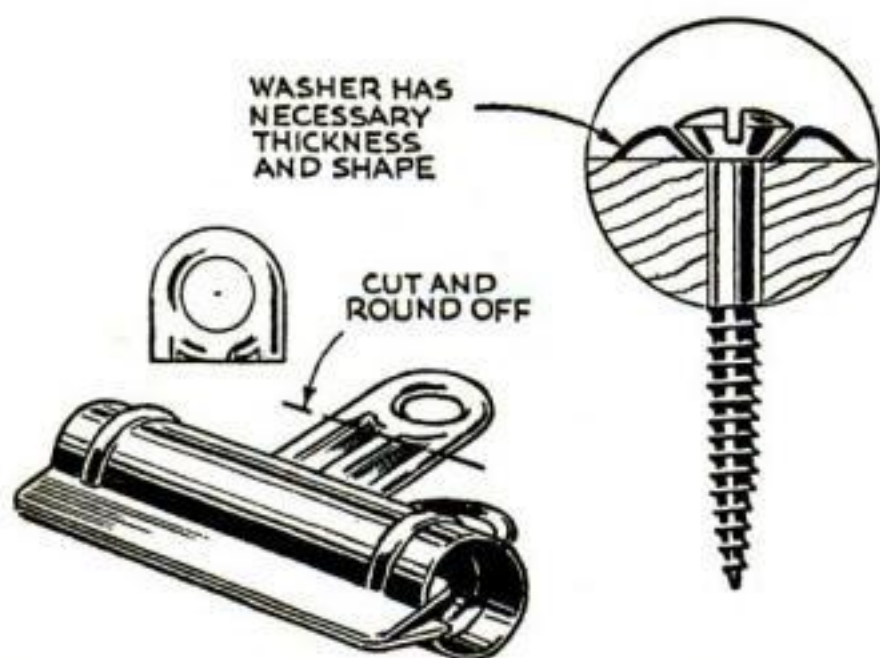
FROM PS READERS



Now Watch the Funny Birdie

HAVING trouble getting youngsters to give you the expression you'd like for a photo? Try my trick. I sketch a funny face on a paper plate and thumbtack the

plate to a stick. Keeping the face turned away, I pose the subject. When everything's ready, I quickly turn the face to view. Click—and I've got what I want.—*G. D. Farkell, White Bear Lake, Minn.*



Washer from a Clip Handle

WHEN you need a countersunk washer under a screw in soft wood, leather, auto trim, or materials that a screw head alone would penetrate, a fair one can be made from a spring-type paper clip. Use tin snips to cut off one holed thumb end above the clamp. Such clamps come in several sizes, and you usually can find a good fit.—*Harry Walton, White Plains, N. Y.*

▶▶▶OUR wall clock was becoming so noisy it was driving us out of the room until I removed the back and blew in powdered graphite. I left the clock on its back for several days until the graphite worked into the bearings. This stopped the noise.—*W. R. Clark, Houston, Tex.*

PS Favorite

Originally published in November '55 PS, this article has brought so many inquiries in the six years since that it is being rerun. If you remember any other old classics that you'd like to see again, we'd be pleased to have you send in your nominations.



What Steel Is That?

All of it looks pretty much alike, but there are simple tests that will help you pick out the type best suited to the job

By John Burroughs

WHEN the man in the machine shop said I could help myself, I fished the piece of steel out of the scrap barrel. It was a bar about $\frac{1}{8}$ " thick, $1\frac{1}{4}$ " wide, and 10" long—just the right size for the blade of the sheath knife I wanted to make. I put it in my pocket and went home happier than a pack rat with a new penny.

But then I began to wonder what kind of steel it was. Suppose I heat-treated it, fitted grips, and worked down the cutting edge—only to find that I had wasted all my work on the wrong stock.

That evening I chased over to ask

Dutch Morgan whether the bar would make a civilized knife. I found him in his basement, inching the flame of his blowtorch along an old clock mainspring.

"Making a cookie cutter," our best tool-and-die man admitted sheepishly. "Betty's invited the girls in her club to a get-together, and she thought it would be ducky to serve cookies shaped like the club emblem. I'm softening up this spring so I can bend it to outline. Then I'll solder it to a backing plate."

I showed Dutch my piece of steel. "Is this the stuff they use for cutlery?"

Dutch ran his thumb along one edge of the bar. "Ground stock," he said. "It's probably a piece of electric-furnace

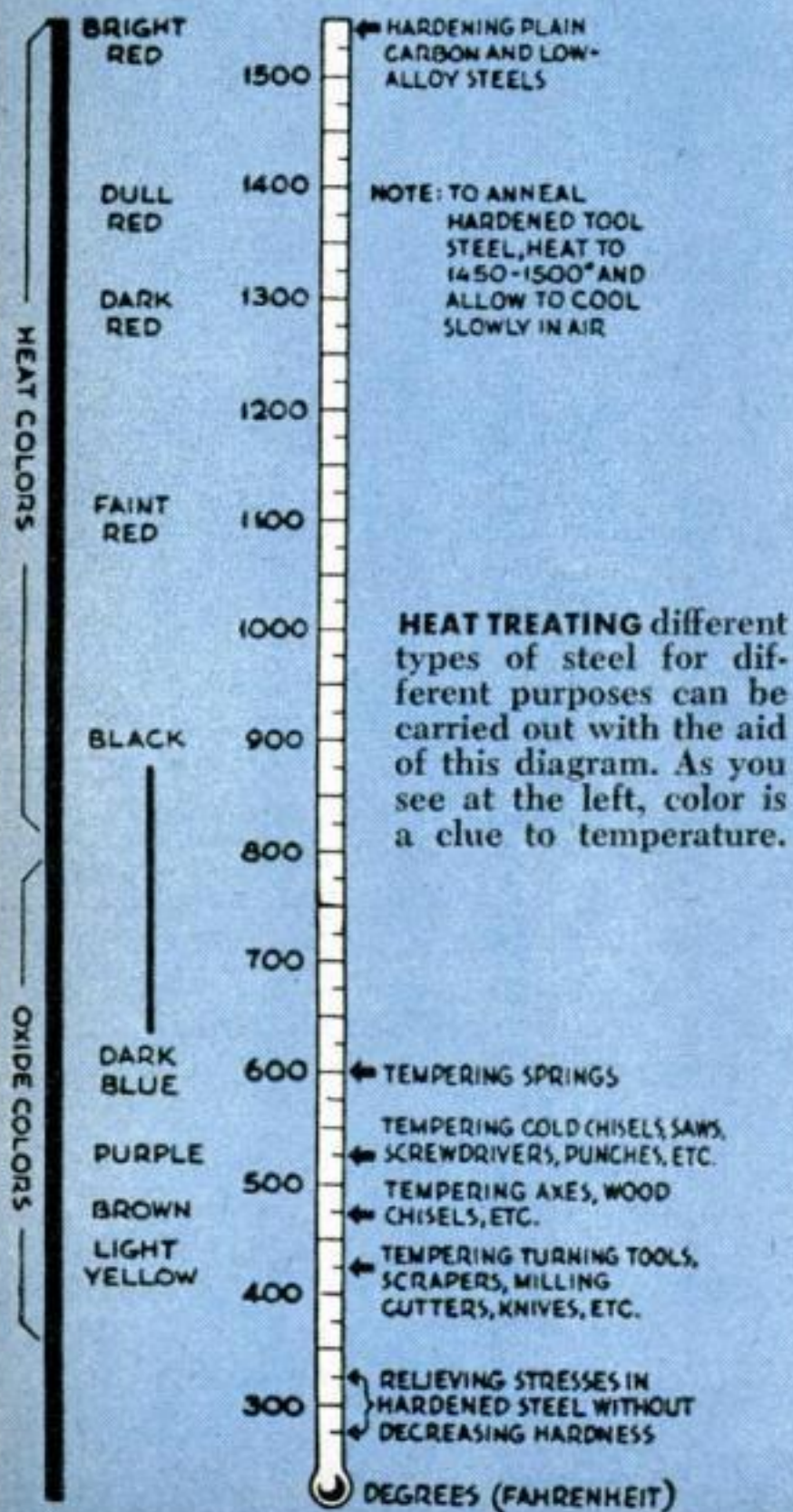


These tests tell you what steel you're using



FILE TEST: Mild steel files easily; tempered tool steel is fairly hard to file; and hardened, high-carbon steel can't be filed at all. Between the first two types are medium-carbon steel and annealed (softened) tool steel. The difference between these can't be detected by a file test.

HARDABILITY TEST: To find out whether fairly easily filed stock is medium-carbon steel or annealed, high-carbon tool steel, heat a sample until it glows bright red, and then plunge it into a can of oil. If it comes out file-hard, you've got yourself a piece of tool steel.



tool steel. Run-of-the-mill machine steel wouldn't have a ground finish."

What the sparks can tell. Loosening a screw, he removed the guard from his grinder and switched on the motor. Touching the stock to the top of the wheel, he studied the shower of sparks that streamed out horizontally.

"That's what I thought," he nodded. "It's a low-alloy chrome-vanadium tool steel. About point 90 or 1-point-10 carbon. Yeah, it'll make you a good knife."

I was impressed. "You mean you can tell all that from the sparks?"

"It doesn't give you a complete analysis," he admitted. "But it's a quick way to tell one steel from another. Here, try it. As a start, look for sparks that break up in bursts. The more bursts, the more carbon content."

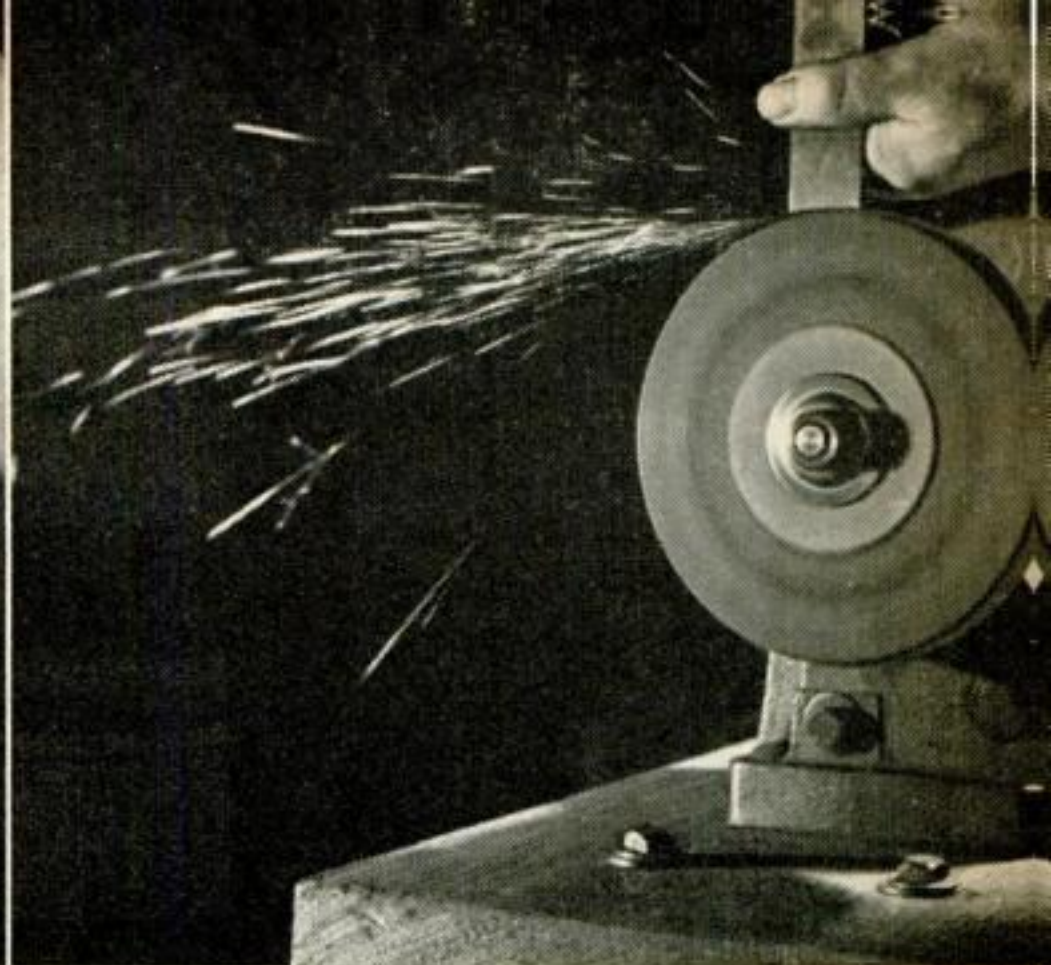
I did as he suggested, taking experimental grinds at the tool steel, a nail, the end of a file, and the blade of my pocket knife. "The fireworks sure are different," I admitted.

The hardening test. "Want to whack a half-inch off your ground stock and try hardening it in oil?" Dutch asked.

While I went at the bar with a hacksaw, Dutch brought a can of oil from his garage, and pumped up the blowtorch. Propping on a firebrick the bit of metal I'd cut off, we heated it red-hot. With his pliers, Dutch snatched it up and



SCRATCH TEST: Draw a corner of the hardened sample across a piece of glass. Fully hardened high-carbon steel will leave scratches on the surface. This kind must be worked while annealed, then hardened, and, finally, reheated at about 400 degrees to relieve internal strains.

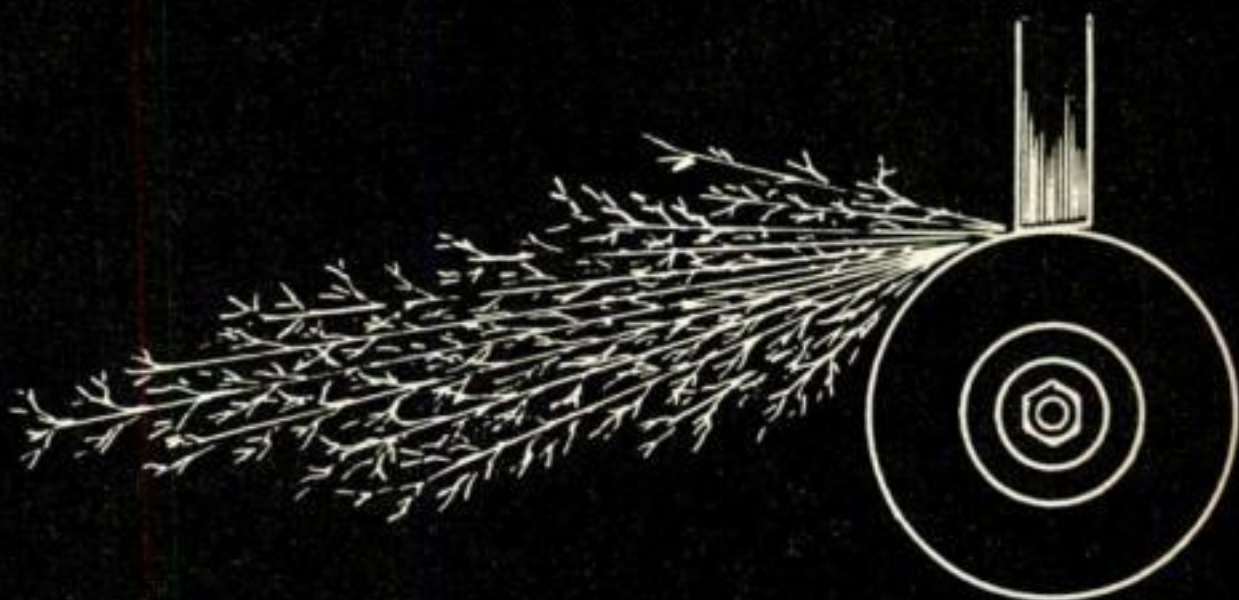


SPARK TEST: Touch the stock to a grinding wheel and study the shower of sparks in subdued light. The pattern will tell you the approximate carbon content, whether the steel is alloyed, and with what. Three typical spark patterns are shown in the drawings below.

MILD STEEL throws off strong, light-yellow lines ending in brilliant, white, orange-tipped tongues. Interspersed with the lines are a few simple carbon bursts.



HIGH-CARBON TOOL STEEL sparkles with fine, feathery bursts. The more plentiful and complex the bursts, the higher the carbon content. Neither hardening nor annealing changes the pattern.



LOW-ALLOY STEEL is identified by disjointed orange lines, with some carbon bursts which the alloying metals tend to suppress. Forked tongues at the end of the spark stream identify nickel; long dark-yellow lines, chrome; very bright sparks with increased spray around the wheel, manganese; and red-brown lines with bright-orange tongues, tungsten.



Typical jobs for various steels



HOT-ROLLED MILD STEEL is too low in carbon content to harden when heated. Tough, it can be twisted or bent, and it welds easily. Use it for assemblies like this decorative stair rail.



COLD-ROLLED MACHINE STEEL, which comes in bars, rods, and plate, is good for shafting and structural parts. Rolling it cold toughens this low-carbon steel and gives it a smooth finish.

dunked it in the oil. When it had cooled he wiped it and tossed it to me.

"Try scratching that bottle on the bench," he said. Sure enough, the steel scratched the glass.

"It works," I admitted, "but I don't see why. How come only high-carbon steels harden? Where does the carbon get in the act?"

The point system. "It forms hard carbides when you quench the stock. Any steel with more than 70 points of carbon will turn file-hard."

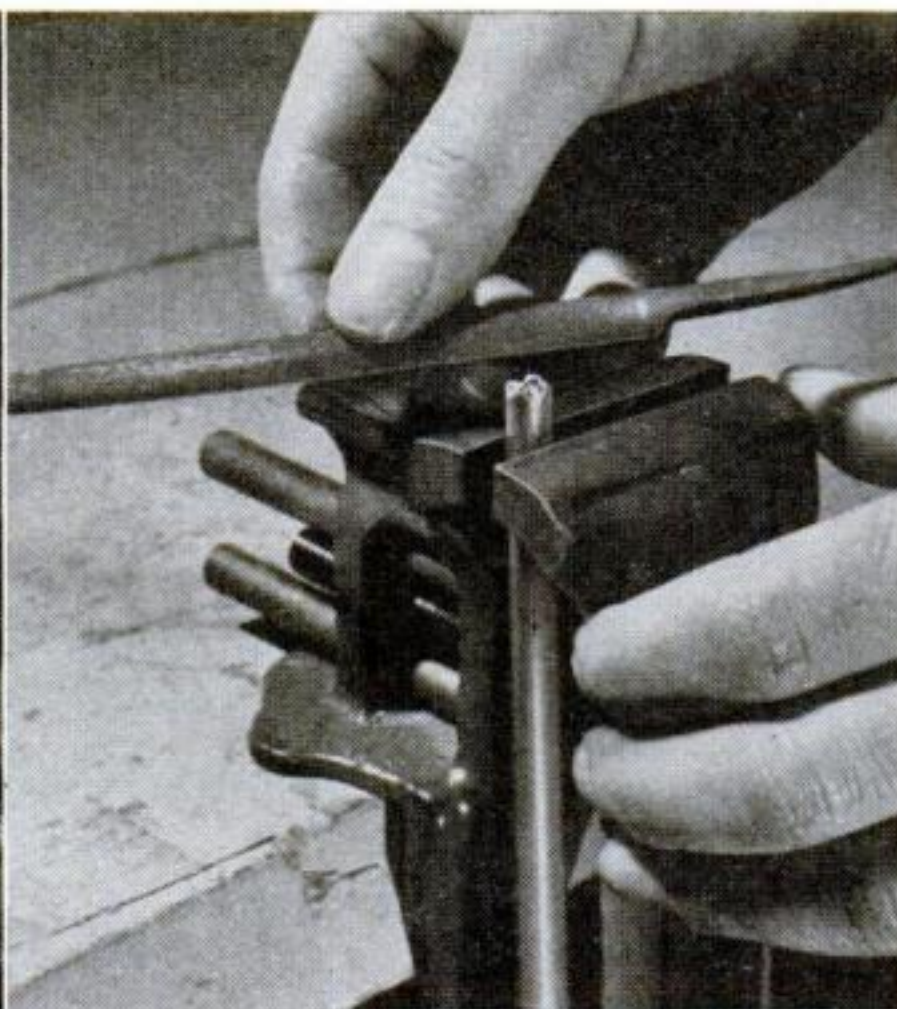
"Points?"

"That's just a convenient way to express the carbon content. A point is one-hundredth of one percent. The whole deal is a little like making fudge. How a batch of steel turns out depends on what you throw in the pot, how you cook it, and how you cool it. It's either soft and gooey—tough, you'd say—or it's hard and brittle."

Now that I thought of it, I didn't know anything about iron or steel making. So I pumped Dutch on that, too.

"It's like this," he explained. "First you fire up some iron ore, coke, and limestone, and pretty soon molten iron runs out at the bottom. If you pour it into molds, it becomes cast iron.

[Continued on page 218]



HIGH-CARBON STEEL can be worked with comparative ease when annealed. This is the stock you use for making special tools like this star-tipped punch, lathe-tool bits, or knives.



Short Cuts and Tips

FROM PS READERS

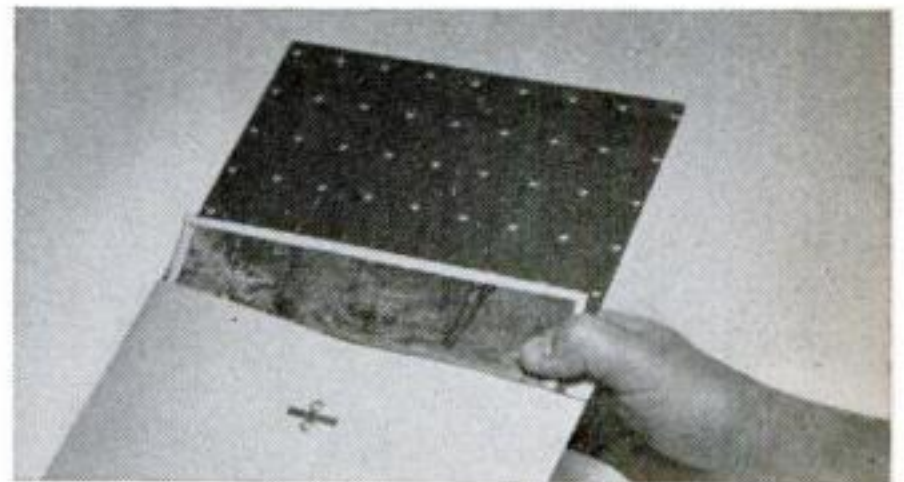
Tomato Basket Holds Shine Kit

BECAUSE it has a handle, one of those rectangular tomato baskets from the market will serve nicely as a home shoeshine kit or portable tool kit. The length of the basket, about 2', is just right for holding the tools or shining equipment you need.—*Marylu Walters, Syracuse, N. Y.*



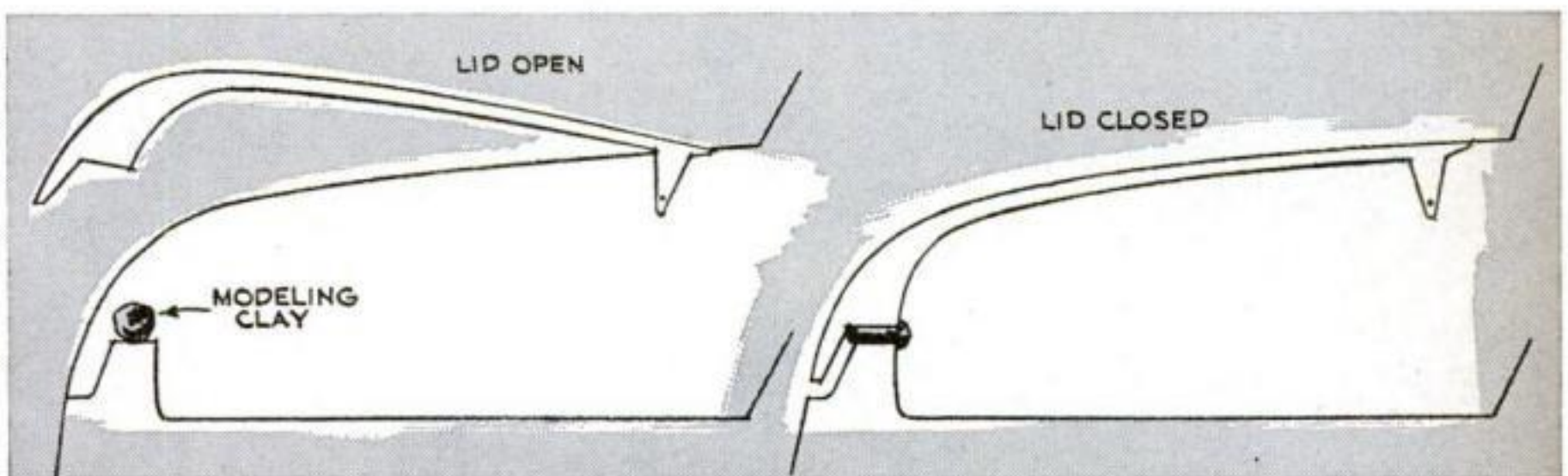
Fold-Away Shoe Scraper

ATTACH a large strap hinge low on the wall outside the entrance to your house. It makes a handy shoe scraper for mud or snow. When not in use, the long leaf folds back flat where it won't be a hazard.—*Anthony Capotosto, Jersey City, N. J.*



Bend-Proof Photo Packing

TO DISCOURAGE postmen from bending packages of photos to get them into a small mailbox, reinforce the packages with scrap pieces of perforated hardboard. These add only a few cents to the postage.—*R. Hertzberg, Douglaston, N. Y.*



For Hard-to-Measure Spots

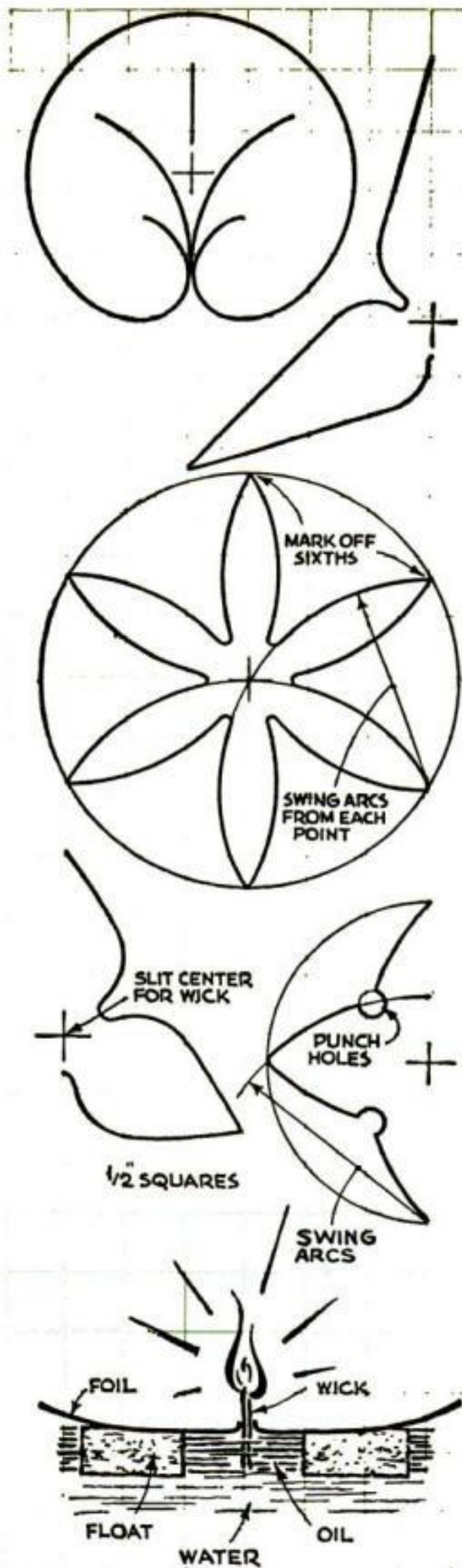
I HAD to know the clearance between the lid and latch of my car trunk to install a new gasket. To measure it, I borrowed some of Junior's modeling clay. A wad of clay, placed at the critical spot

and compressed by the lid, gave me the dimension.

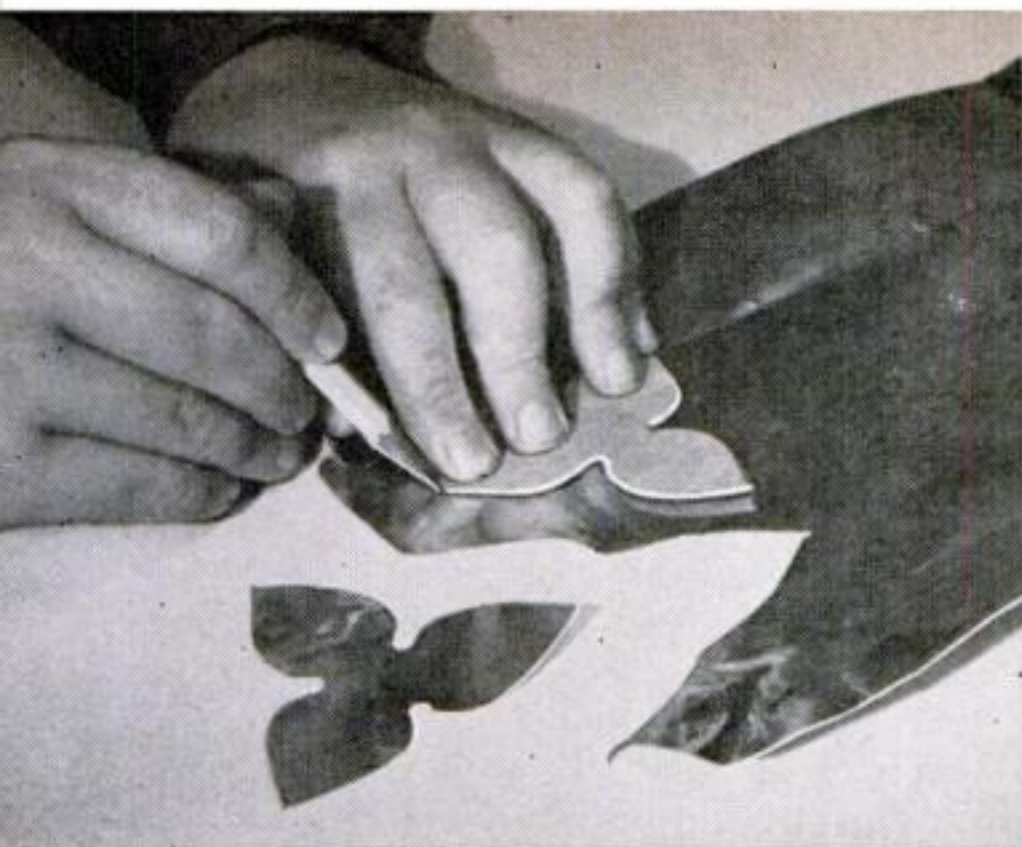
The same idea will work as well for other interior measurements. You may have to oil some surfaces or insert a sheet of waxed paper to keep the clay from sticking.—*C. T. Pearson, Vermillion, S. D.*

Floating Candlelight

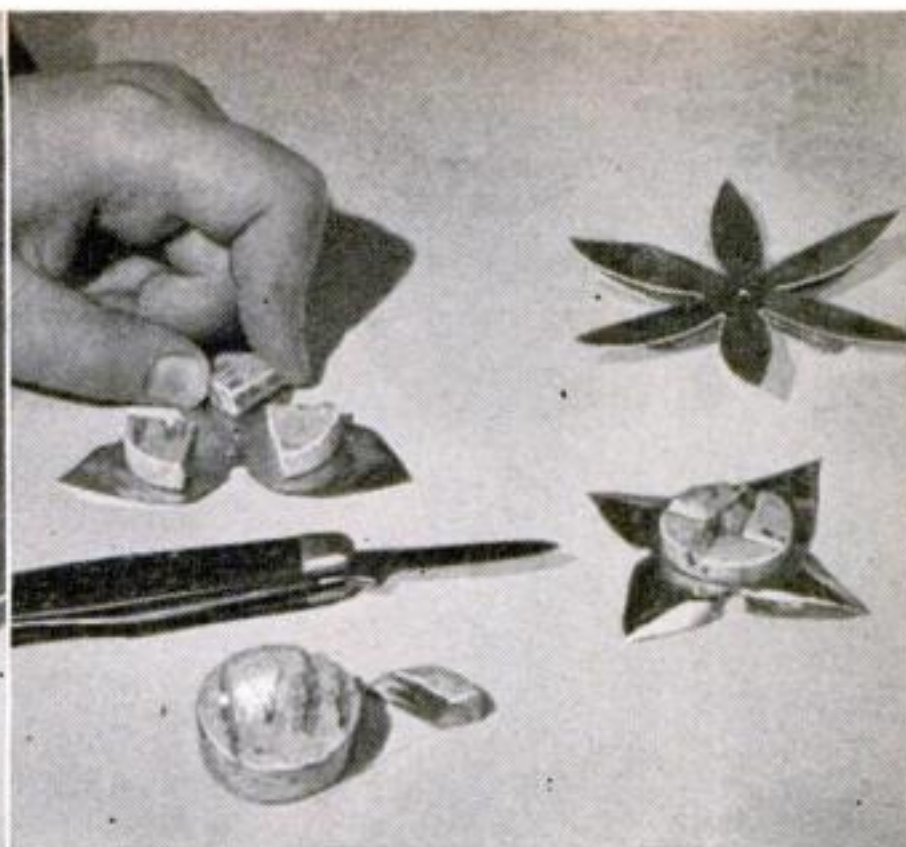
Pour cooking oil on water, light wicks in aluminum-foil holders, and you have a different kind of light



FESTIVE TABLE LIGHTS are fueled by a layer of cooking oil floating on water. Big glass marbles or weighted wax flowers may be immersed in the water to add color and enhance the effect.



USE A COMPASS to lay out flowerlike geometric figures like these, or space the full-size petals around a circle. Neat inside corners are formed by a paper punch. Scissors serve to cut foil salvaged from a ready-mix cake pan. Rub out the fold marks with a rounded object.



CUT FLOATS thick enough to lift the foil out of the oil layer. The big circular float shown on the four-petalled wick carrier above must be deeply grooved on the underside to let oil reach the wick in the center. Cement or staple the floats to the foil wick carriers.

GOLDEN flames that seem to float on water shed a fascinating kind of light on festive tables. Unlike candles, these floating lights will never drip wax or droop in a warm room. The fuel is ordinary cooking oil. A thin layer on top of the water burns for hours, without smoke, odor, or explosion hazard.

Cut wick carriers out of extra-heavy aluminum foil, such as frozen precooked foods and ready-mixed cake doughs are sold in, using ordinary scissors. Lily pads or flowerlike geometric patterns are especially apt, and colored foil is especially decorative. But don't use metallized paper; it isn't fireproof.

Make the floats of cork or balsa about $\frac{1}{4}$ " thick. Cut them slightly smaller than individual petals so they won't show from the top. Apply a coat of waterproof contact cement to each float and to the foil, let it dry, and carefully press the float into position. In the center of each wick carrier, punch a small hole with a sharp point, or make two tiny cross slits.

Wicks are $\frac{5}{8}$ " lengths of soft, absorbent cord, or wicking melted out of a candle. Cord can be dipped in hot wax as well; waxed wicks are easier to push into the carriers, and they light more readily. Insert wicks halfway into the holes.

After pouring water into a bowl, add



POWER FAILURE? An emergency light made in a jiffy from a foil milk-bottle top, cork, and soft string will burn three hours on a thin layer of oil. Staple three floats to the underside of the cap (or simply crease the foil under them). Flatten foil between floats to let oil reach the wick. Place enough water in a wide-mouthed jar to bring the flame above the rim.

enough cooking oil to spread over the entire surface. Drop the lights in gently, wait for unwaxed wicks to draw up the oil, and light.

Should a flame be long and smoky, the wick is overlong or too thick. Try slightly thinner cord, or pull out a few strands. If flames sputter, the oil is running out. Lights can be blown out and relit, but if wicks become water-soaked, replace them. To save unused oil, pour it with the water into a jar you can cap. Wipe off the foil lights before storing them and discard used wicks.—Harry Walton.

5 Projects for the Man Who Can Weld



Sturdy Mount for a Leg Vise

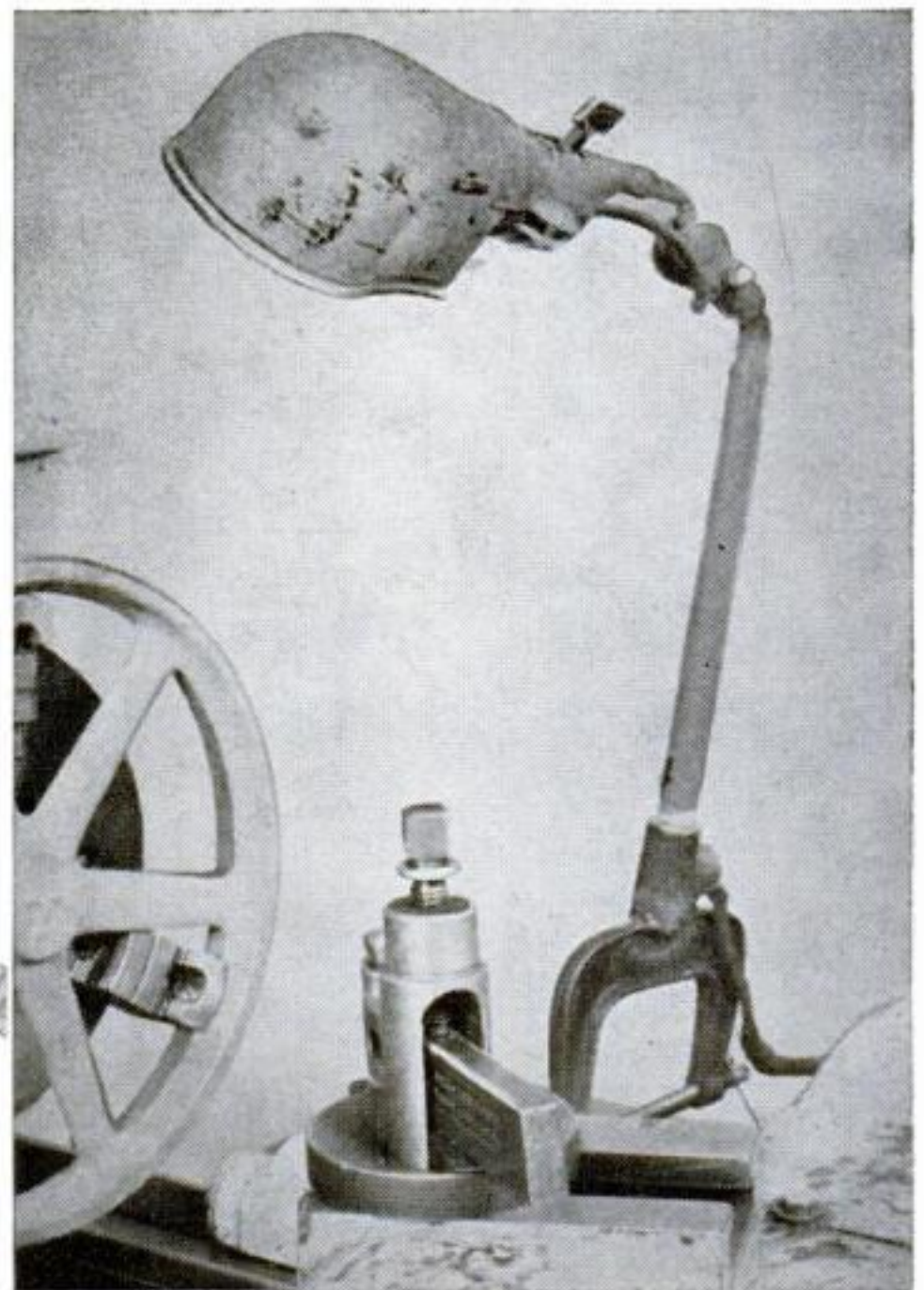
A JUNKED car flywheel, crankshaft, and camshaft, combined with a bit of welding, produced this mount for a leg vise. The flywheel and crankshaft were left bolted together.

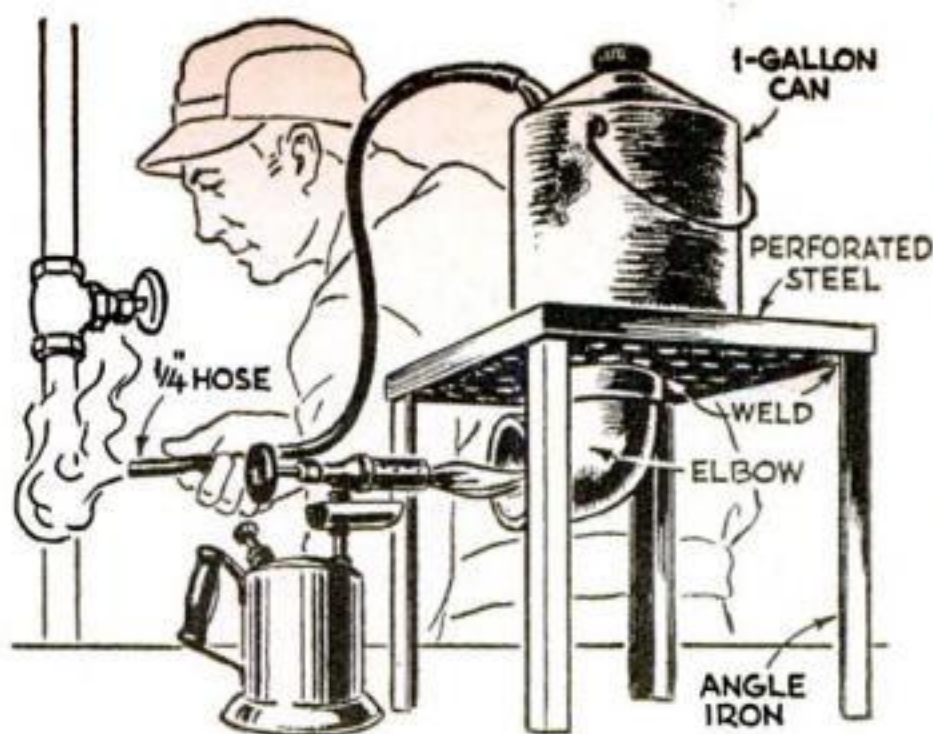
A small piece of boiler plate welded to the free end of the crankshaft provides a base for the vise. The camshaft was fitted into the leg socket of the vise to serve as the leg; the other end was welded to the flywheel. A piece of steel strap welded between the two shafts at a convenient mid-point adds to the rigidity.

At 170 pounds the mounted vise is quite stable, yet it can be tilted and rolled on the flywheel rim like a barrel. The various surfaces of the crankshaft provide an assortment of anvils and fixed dollies for bending and shaping.—Robert T. Marshall, Emmitsburg, Md.

Clamp-On Machine Light Quickly Attaches Anywhere

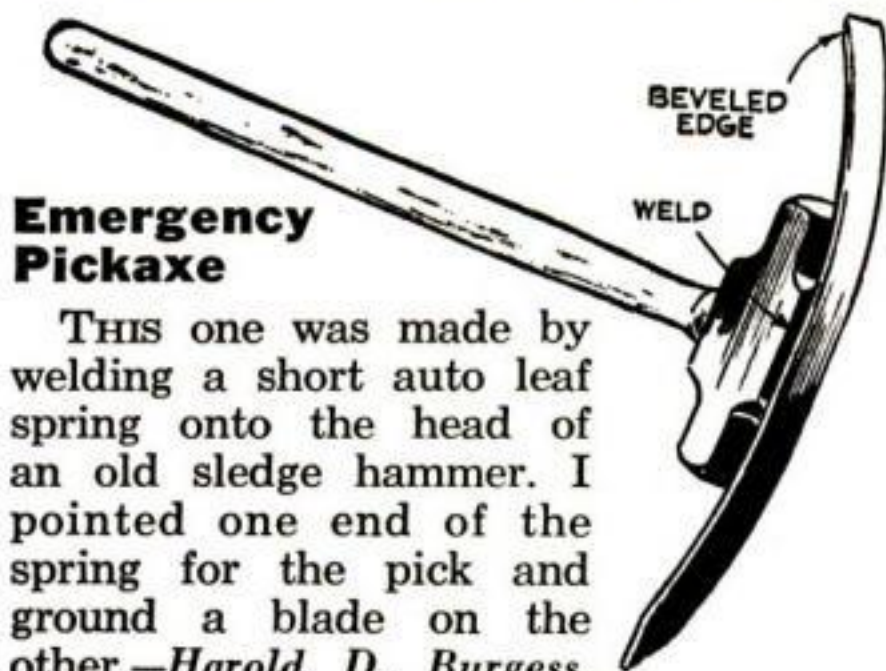
THERE'S almost no place in a shop where this work light wouldn't be useful. It was made by welding a cheap C clamp to a pipe tee and screwing the tee to the stem of an old swivel-shank machine light. Before assembly, the lamp cord was run out through the side opening of the tee. The clamp makes it possible to attach the lamp to any tool or table.—H. J. Gerber, Stillwater, Okla.





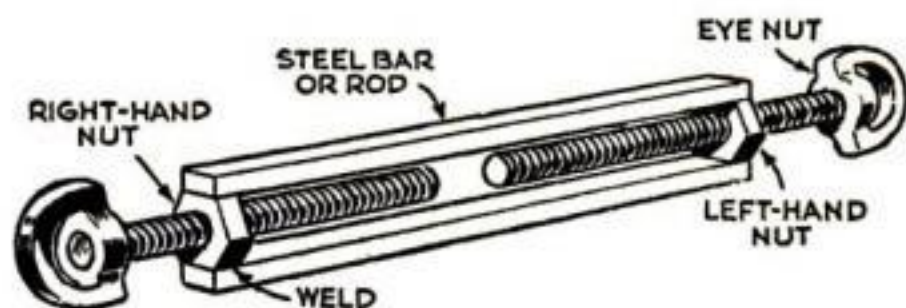
Low-Cost Pipe-Thawing Outfit

THAWING frozen pipes is done quickly and safely with a homemade steam-generating rig devised by the Department of Parks and Recreation in Lansing, Mich. The portable steam generator uses an ordinary gallon can with a hose slipped over the spout to carry steam to the thawing point. A table of perforated steel or steel mesh, with legs welded on, supports the can. A large pipe elbow conducts heat to the can from a blowtorch.



Emergency Pickaxe

THIS one was made by welding a short auto leaf spring onto the head of an old sledge hammer. I pointed one end of the spring for the pick and ground a blade on the other.—*Harold D. Burgess, Battle Creek, Mich.*

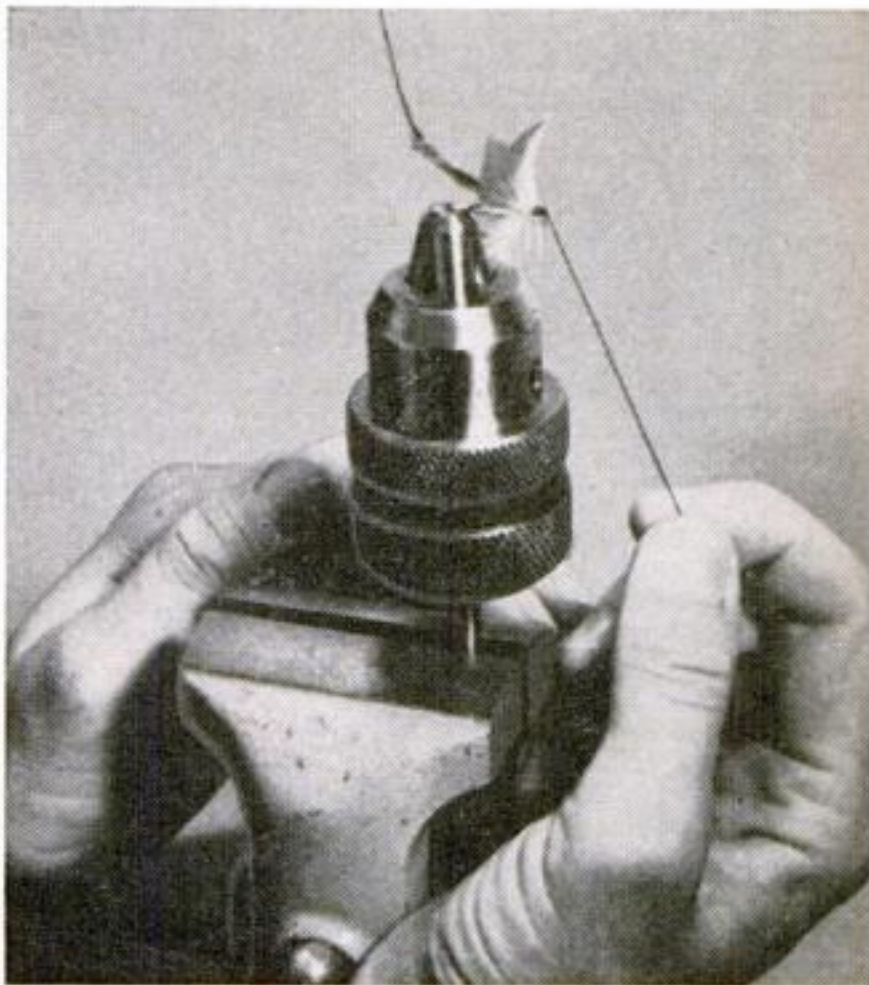


Making Your Own Turnbuckles

EXTRA-BIG turnbuckles are expensive and often hard to find. You can make your own turnbuckles to any length by welding steel bars or rods to large nuts. Use a left-hand-threaded nut and bolt at one end.—*M. W. Loftus, Chicago.*

Vise for Tying Flies

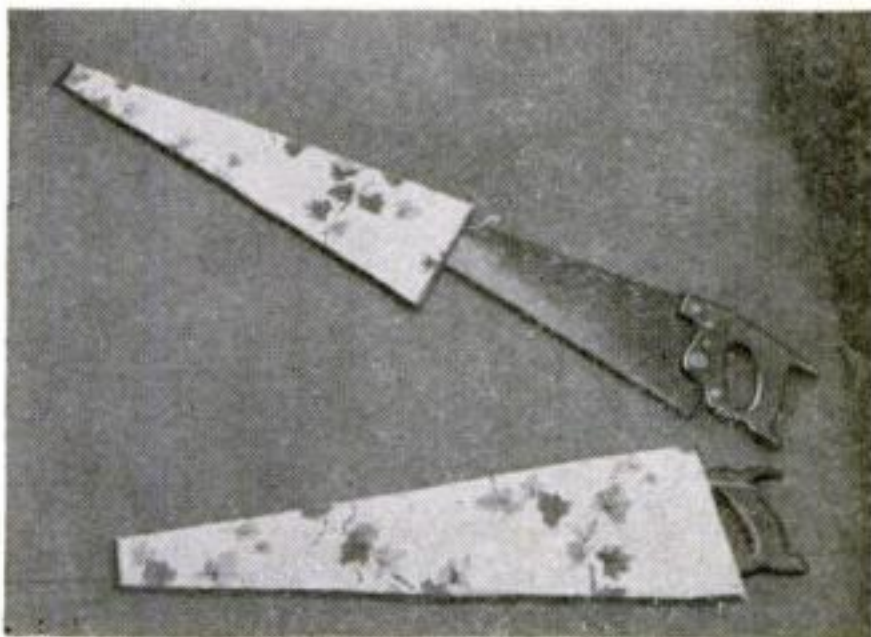
A SMALL drill chuck held in a vise makes an ideal vise for tying flies. A hook placed between two of the jaws will be tightly held when the chuck is locked.—*Robert Micals, Freehold, N. J.*



▶▶▶ No SHOP in town could supply a tailpipe extension for my foreign car, so I trimmed a chrome extension from an old vacuum cleaner to the length I needed. I drilled a hole in one end and turned in a bolt to serve as a lock screw when the tube was slipped over the tailpipe.—*Kenneth E. Philbrook, Dixmont, Me.*

One Wife's Good Deed

I MADE these covers from heavy oilcloth for my husband's handsaws. They keep the teeth from being damaged by other tools. A loop of elastic slips over the saw handle to hold the covers in place.—*Mrs. C. Wayne Close, Glendale, Ore.*



First Turbine Fire Engine

[Continued from page 106]

faster than any of them. It'll do even better than that. It ran its test under a handicap that has since been removed: a rear-end ratio of 6.833:1. Its rivals all had the Department's standard 7.2:1 rear-end ratio when they made the climb.

Requiring no warm-up, the turbine job is ready to go full-tilt within 10 seconds after its driver jabs the starter button on the dash. Unlike fire trucks with piston engines, the Turbo Chief never requires choking, never runs the risk of vapor lock.

"Where we really expect it to delight us is in maintenance," said Chief Murray. "The Boeing people tell us that a couple of mechanics can overhaul the turbine engine in a day. It has only seven moving parts, I hear. Why, one of our reciprocating engines can be down as long as two months—and we end up with a bill of two or three thousand bucks."

Greatly reduced maintenance expense is expected to more than offset the premium price of about \$10,000 more for the turbine-powered pumper than for a conventional one. It cost San Francisco about a third more than a piston engine of comparable power.

It also consumes fuel about 50 percent faster than do any of the Department's conventional 330-hp. pumpers. But it burns low-priced diesel fuel or kerosene. The others use gasoline.

It never needs an oil change, for the lubricating oil does not get contaminated. There's no point where the hot gas comes in contact with it.

It's a simple engine. The Boeing gas-turbine engine has two main sections. The first develops the power. The second conveys it, through reduction gears, to a clutch and standard fire-truck transmission of five forward speeds and one reverse.

Each section of the engine has a separate shaft and its own turbine wheel. Though the two shafts are in line, there is no mechanical connection between them. They rotate independently.

Power is produced by burning a mixture of fuel and compressed air, and aiming the resultant torrent of 1,700-degree gas at the curved blades of the first turbine wheel. This turbine is on the same shaft as the impeller, which sucks

air into the compressor. As the driver of the Turbo Chief steps on the accelerator, the fuel flow increases, the first turbine whirls faster, and the impeller pulls in more air. This rising cycle spins the front shaft to a top limit of 37,000 r.p.m.

Meanwhile, a second turbine—the free power turbine—is motionless until the pumper's brake is released. Then the blast of hot gas streaming through the first turbine starts whirling the second one. Its spin is transmitted through 8.9:1 reduction gears to the output shaft, which has a top speed of about 3,200 r.p.m.

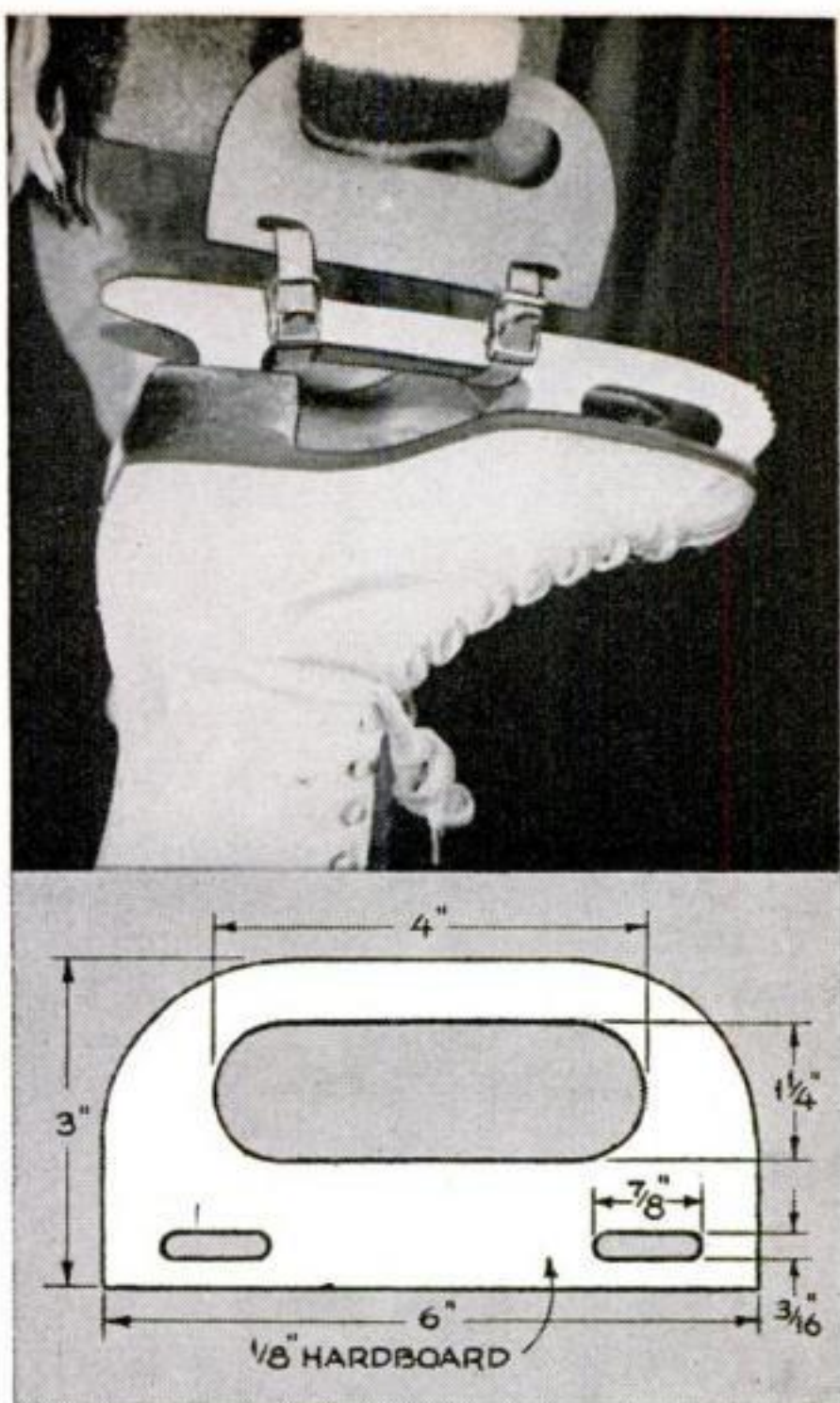
The second turbine. This one acts like a torque converter. When the Turbo Chief's driver brakes the pumper to a stop, the power turbine also stops. The driver doesn't have to touch the clutch. When he steps on the accelerator again, the flow of gas against the power turbine increases, and the vehicle moves ahead in the gear in which it was engaged when it stopped. The effect is as if the Turbo Chief had an automatic transmission.

On fairly level streets, third gear serves for all speeds up to 45 m.p.h. The two lower gears are for hills. The higher ones are reserved for freeway travel.

One interesting and valuable asset of the engine is that the relative velocity between the gas flow and the power turbine's blades increases as that turbine slows down. Torque rises steadily up to the point of stall. The engine gives its best performance at low vehicle speed.

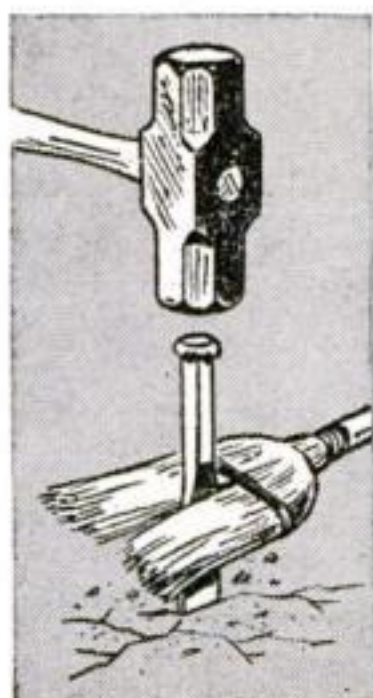
When the driver pushes the starter button, a glow plug is heated. As his finger leaves the button, the starter engages. With a rising whine like a bicycle siren's, it twirls the first turbine to a speed of 3,000 r.p.m. At that point the fuel solenoid opens and the glow plug ignites the fuel-air mixture. The engine comes to life with a deep-toned bellow, spinning the gas-producer turbine to 15,000 r.p.m., which is idle speed. The ignition and starter then drop out. From there on, combustion is continuous, and there is no further need for electrical power.

The engine runs with so little vibration that drivers of the Turbo Chief have entertained admiring colleagues with the old trick of standing a half-dollar on edge on top of the engine compartment while the pumper is idling.



Handle Tames Ice Skates

YOUNGSTERS can carry ice skates without touching the cold and often muddy runners with this handle. It takes only a minute to jigsaw it from $\frac{1}{8}$ " hardboard. Straps looped around the runners and through slots in the handle hold both skates neatly together. When not in use, the skates can be hung on a hook.—*Arthur R. Tanner Jr., Poughkeepsie, N. Y.*



Broom Saves Banged Finger

HERE'S a safe and easy way to hold a chisel when you're breaking concrete or other hard materials. The broom keeps chips from flying and gives your helper a long handle so he can stand way back.—*Thomas K. Powell, San Simeon, Calif.*

Short Cuts and Tips

FROM PS READERS



Foot Wiper on Ladder Rung

WHEN using a ladder in damp and muddy areas, tie a roll of burlap around the bottom rung to serve as a foot wiper. It will prevent a lot of dangerous slips caused by muddy feet.



Unclogging Files with Alcohol

TO PREVENT a file from clogging when you're working soft aluminum, keep it wet with alcohol. The file will last longer and cut more cleanly this way.—*Martin D. Koehler, River Grove, Ill.*

The Tool for



Bending

WIRE bending has always been an artistic delight but a mechanical headache. Now there's an inexpensive forming tool that gets rid of the headache. Your imagination is left free to create an endless variety of useful and decorative objects.

The bender consists of a small metal block with posts around which the wire is curved and a cam-action handle to apply the leverage. It can be clamped in any vise. Slip in a wire, give the handle a pull, and a sharp bend is made in one stroke. By taking a series of small "bites" with the handle, you can turn out smoothly curving arcs and circles to any radius.

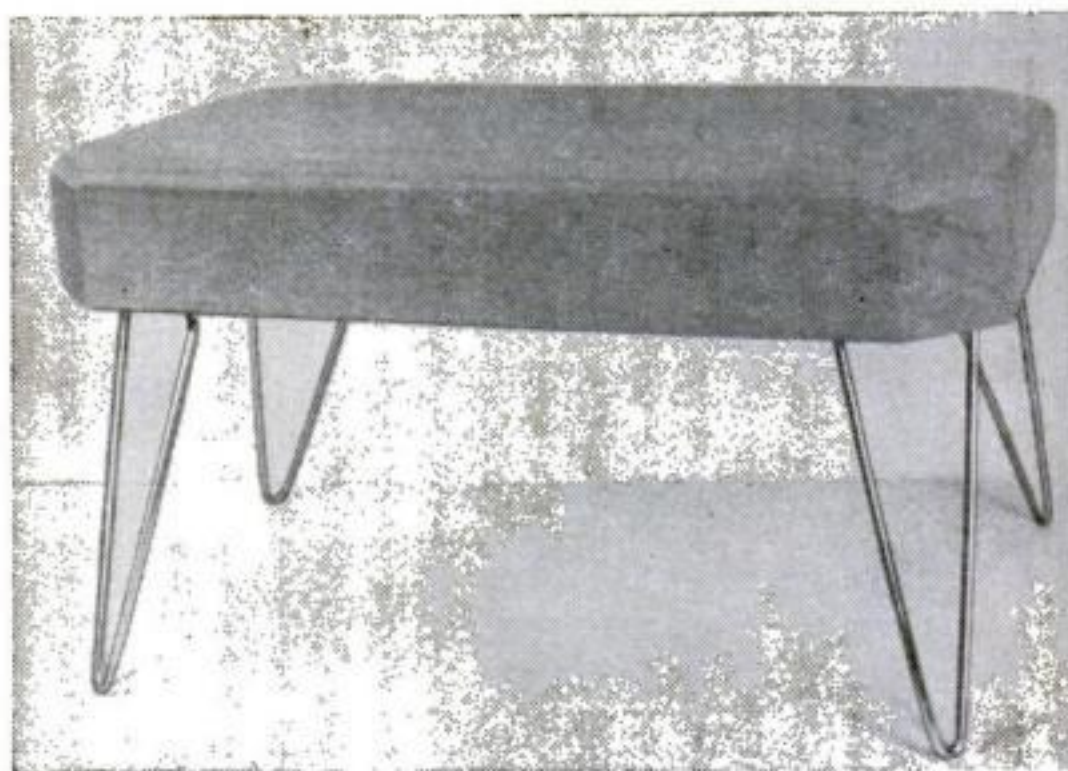
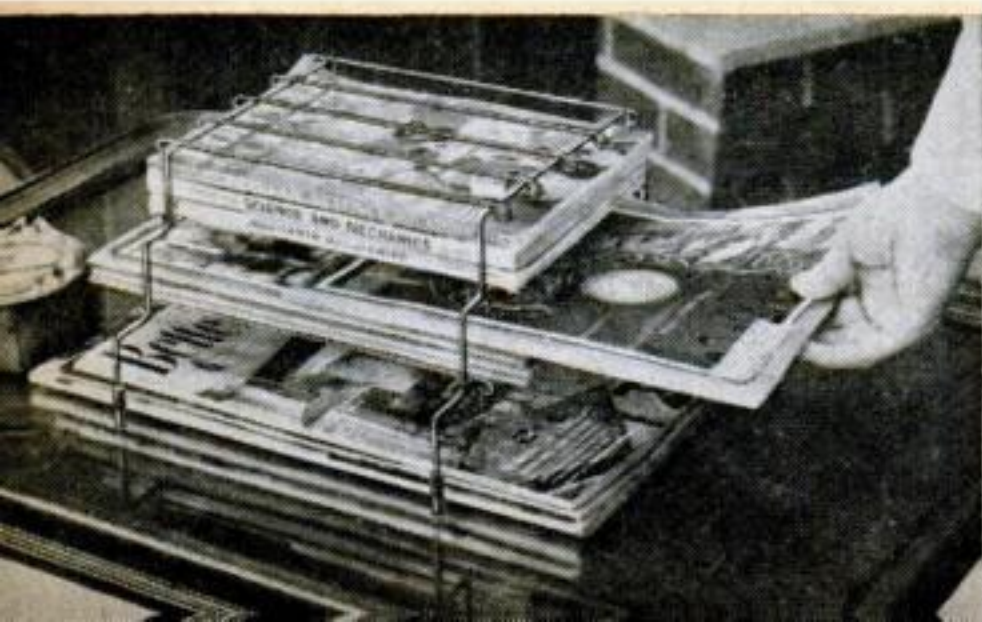
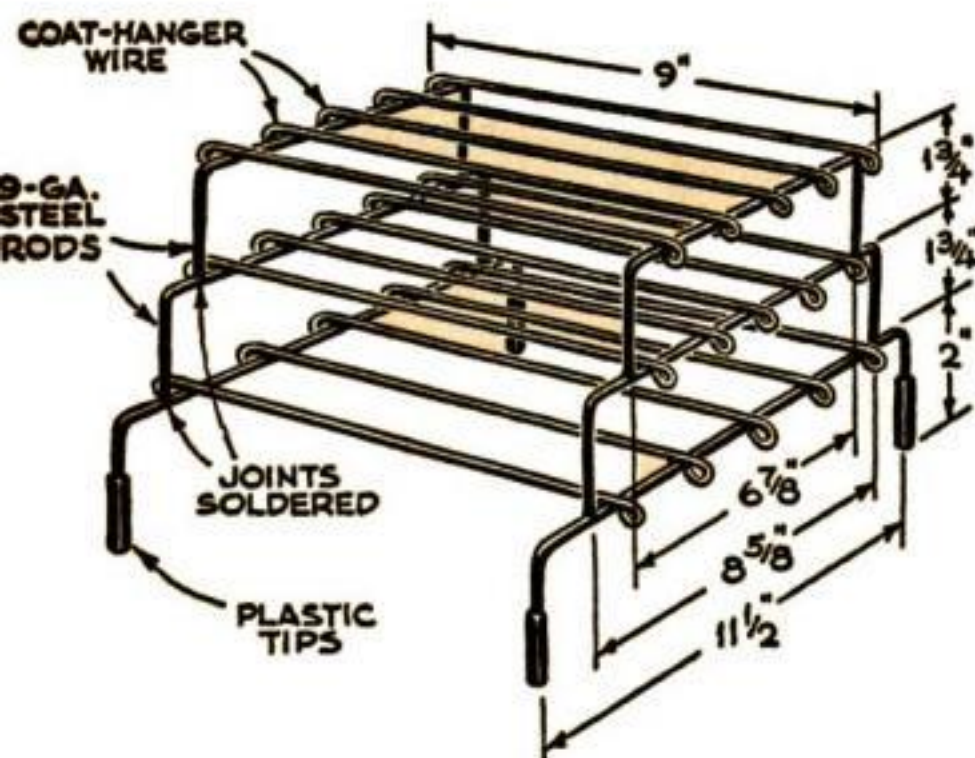
The tool will handle any size wire or

rod—aluminum, copper, bronze, or steel—up to $\frac{3}{8}$ " in diameter. A notched cutter snips the metal to length.

Tiny closed eyes, hooks, graceful spirals, and other intricate shapes take only a few minutes to form. By combining various types of bends in different directions, you can make racks, stands, fixtures for perforated board, furniture legs, letters for signs, chain links, and wire sculpture.

One ready source of wire for the bender is the common metal coat hanger. In most homes these are in oversupply. Coat-hanger joints can be soldered easily, but remember first to scrape off the paint at the joint. Welding-supply shops sell $\frac{1}{8}$ " steel or bronze rods in 3' lengths.

The bending tool, called Wireformer, is sold for about \$3 by the Vinkemulder Mfg. Co., 917 Princeton Blvd., S.E., Grand Rapids, Mich.

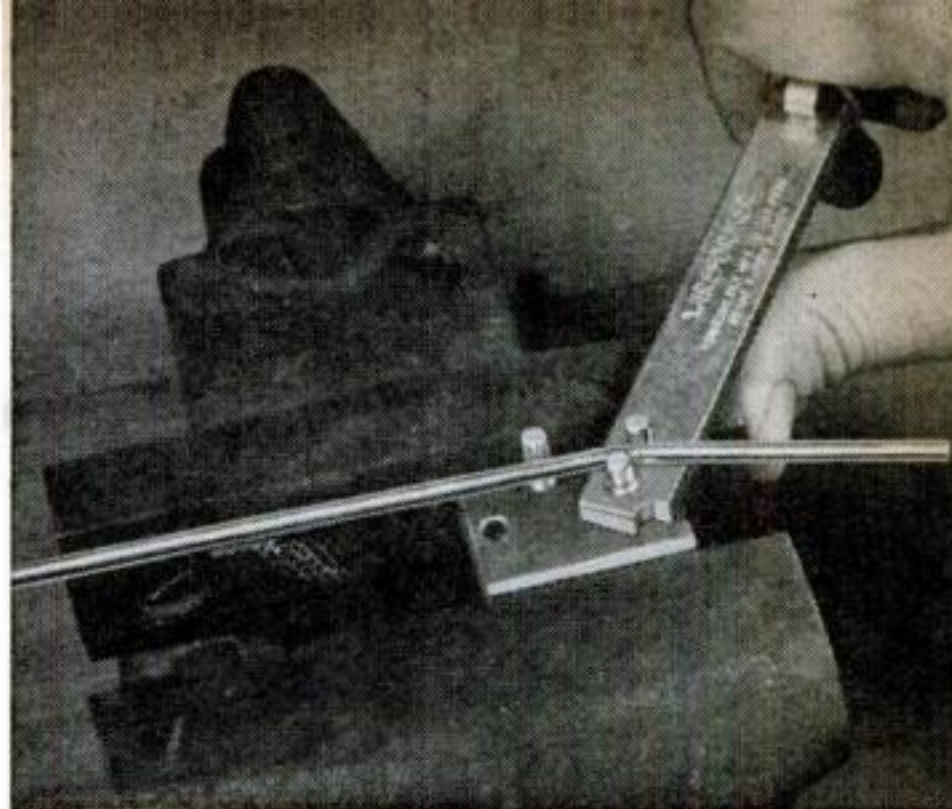
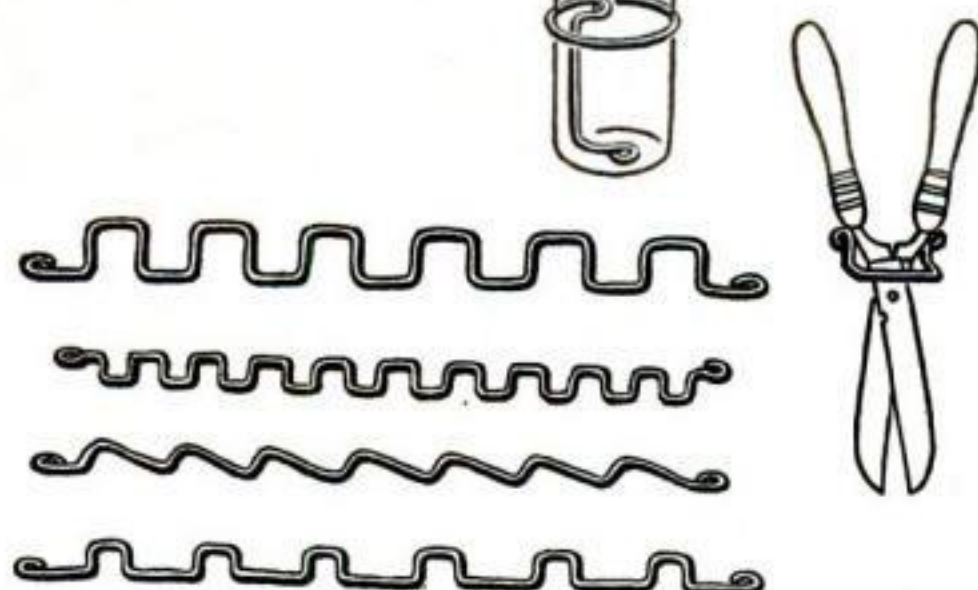


KIDS' TV BENCH is easy job—redwood slab and legs of steel rod bent and inserted in holes.

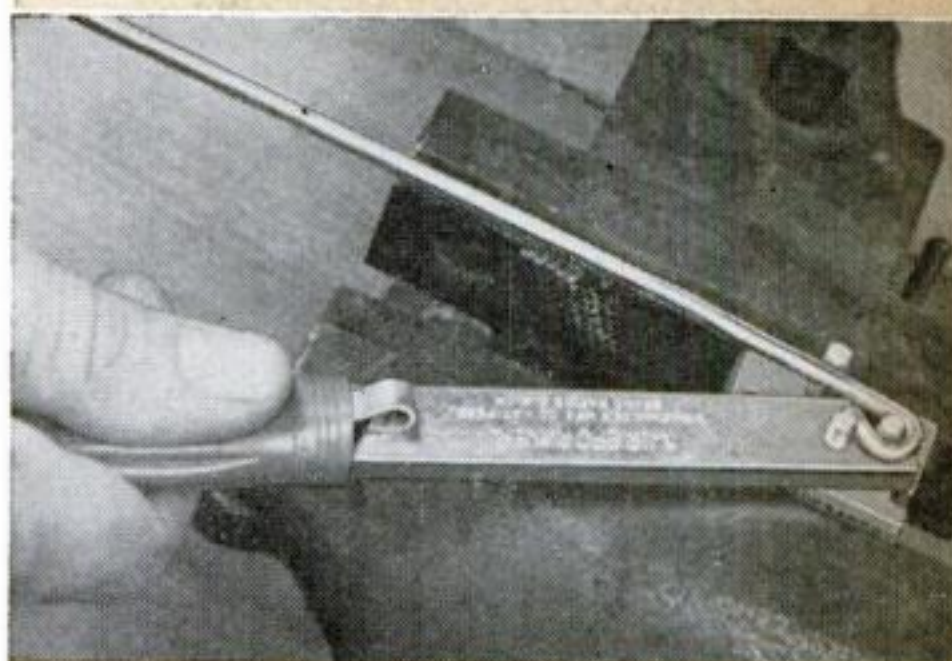
MULTI-DECK MAGAZINE RACK is one of many eye-catching designs. End supports are nine-gauge wire soldered together. Cross pieces come from ordinary wire coat hangers.



Wire

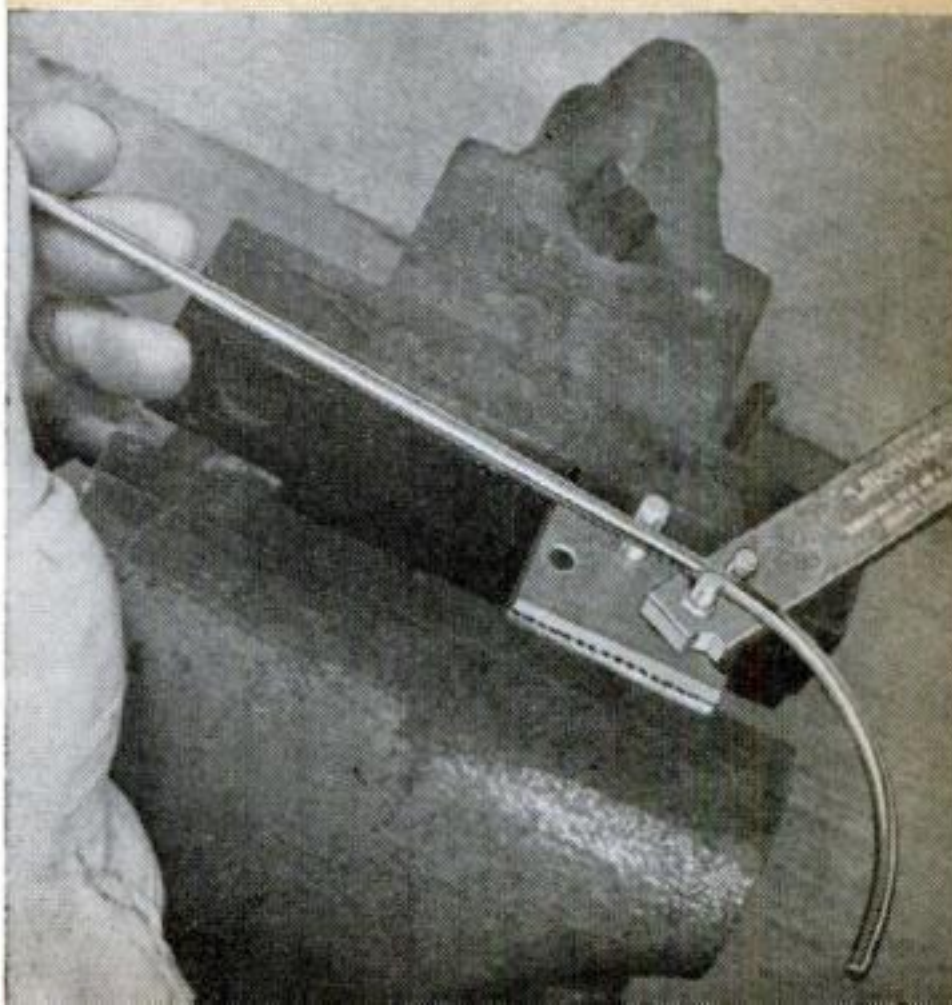


HOW IT WORKS: Tool shapes wire or rod between pins on the handle and a pin on the base. Turning handle clockwise produces right-hand bends; counterclockwise, left-hand bends.



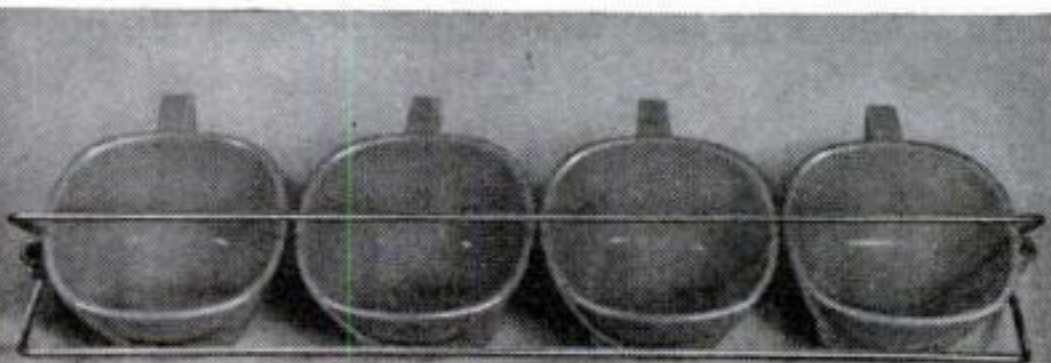
TIGHT BENDS can be made with inside diameters as small as $\frac{3}{16}$ ". Tiny eyes like this make it easy to mount wall brackets. Notch at right side of the bender holds wire for cutting.

GRACEFUL CURVES are made by bending the wire a little at a time. Clip, stored in handle, fits over posts to handle very small wire. Hole in base holds cut ends steady for filing.

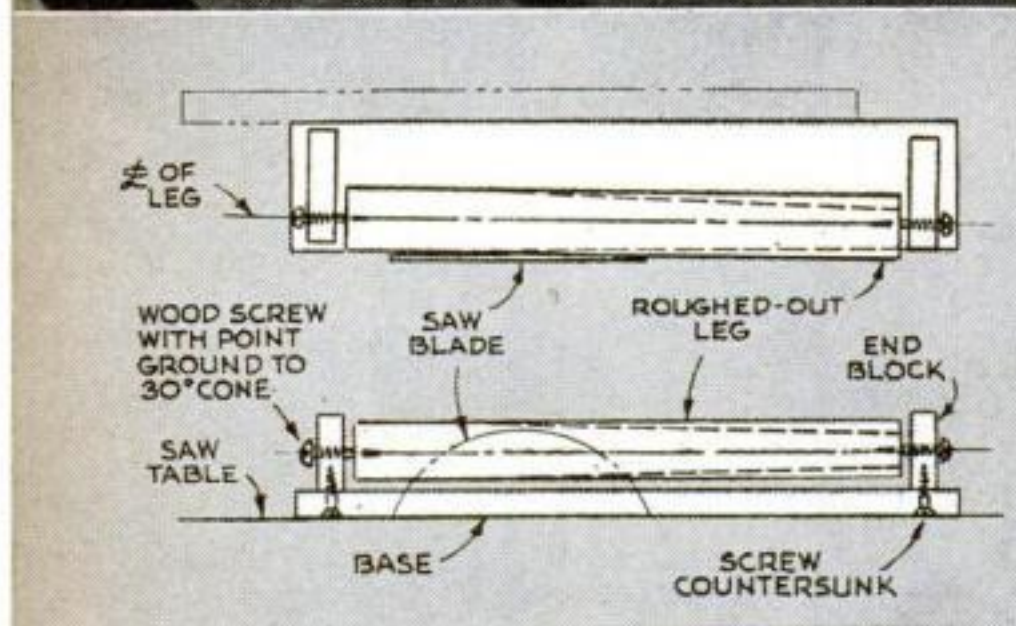
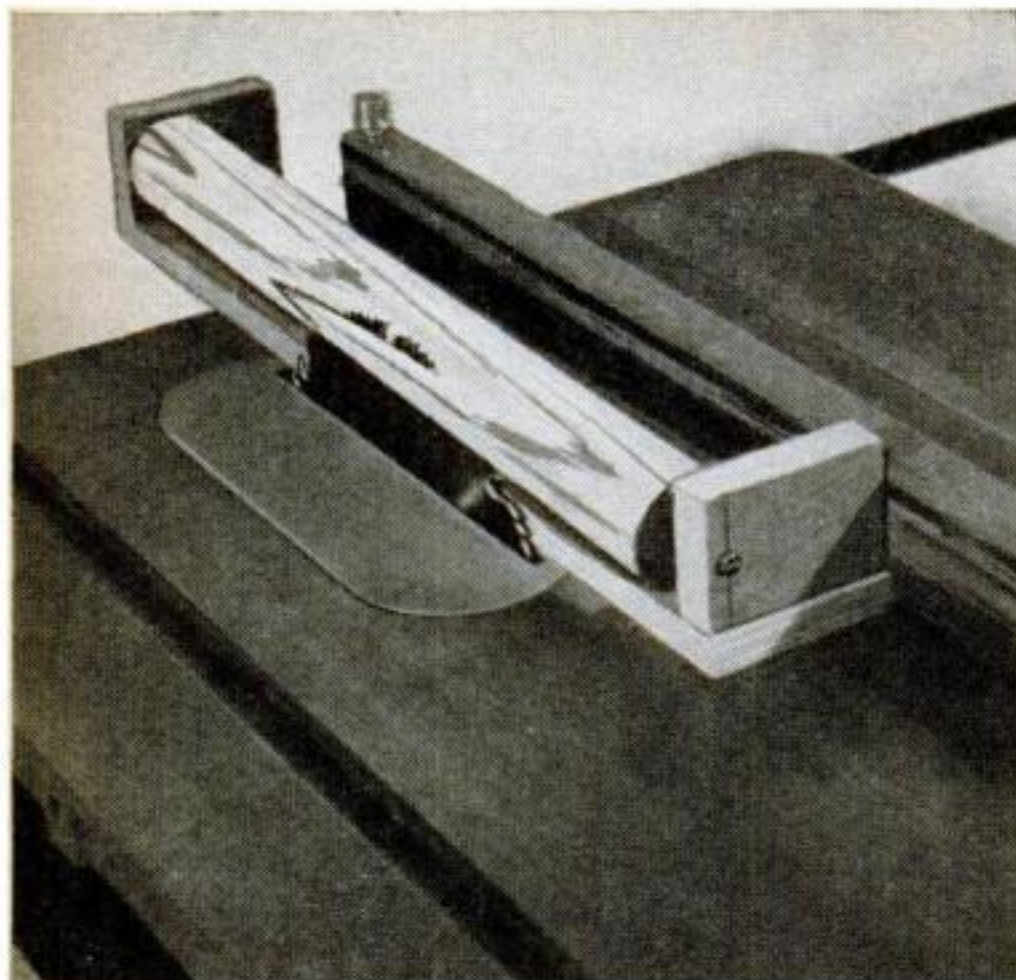


SUNBURST CLOCK: Rays are bent 12" and 24" aluminum rods, dial an 8" disk of $\frac{3}{4}$ "-thick wood painted black, hour markers knockouts from electric service boxes, the hands thin wood.

A RACK FOR CUPS or glassware like this one requires just two 24" lengths of steel rod.



New Twist on an Old Jig



Using this modified taper jig on a table saw, you can cut straight or tapered legs of triangular, square, or hexagonal shape. From a hex leg, it's a simple matter of making a few more passes to trim off the hex corners, and produce a round leg without using a lathe.

Differing from the familiar jig used for tapering flat boards, this one operates in two dimensions, permitting you to rotate the work after each pass over the saw blade. Make the base from $\frac{1}{2}$ " plywood, 4" wide and about $2\frac{1}{2}$ " longer than the legs to be shaped. Screw two $\frac{3}{4}$ " end blocks to the base, setting them at a slight angle, depending on the taper.

Before mounting a leg in the jig, rough cut it to $\frac{1}{8}$ " of finished size by ripping off the corners on the saw. Punch-mark the center of the leg at each end. Mount the leg between the screw centers in the jig, tightening them enough to keep it from rotating. Raise the saw blade to cut about $\frac{1}{4}$ " above the leg's center and set the fence to bring the leg to finished size.

Slide the jig along the fence to make the first cut, then loosen the center screws and give the leg a one-third, one-quarter, or one-sixth turn, depending on the desired shape, and make the next cut. To make a round leg, rotate the work in small increments and make repeated passes until it is round enough to be sanded to final shape.—*Earl L. Manor, San Diego, Calif.*

My Most Embarrassing Shop Moment



I SET the chest in place and stepped back to admire it. I had made it of costly high-grade hardwood to fit precisely inside one of my neighbor's dormer windows.

To my horror, the chest had shrunk. Although its dimensions checked perfectly with my rule, it was exactly 1" too short, 1" too narrow, and 1" too shallow.

Then it hit me. The tip of my rule had broken off earlier and to avoid discarding the tool—unthinkable to my thrifty nature—I had cut off the end to the 1" mark, always adding the missing inch mentally. Always, that is, until this time. I've never forgotten this expensive lesson: It doesn't pay to save money with faulty tools.—*Maxwell W. Flesher, Huntington, W. Va.*

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Do you have a shop blunder that haunts you? PS Will pay \$50 for each such experience published. None can be returned. Keep it brief. Address: Shop Editor, Popular Science Monthly, 355 Lexington Ave., New York 17, N. Y.

tors Council) replied no, they didn't see any great advantage over diggers already on the market.

A few were interested in a closer look. To each of them Kessler sent a "folio": a folder containing a photostat of the patent, photographs of models, and a discussion of the merits of the machine.

This brought more than a nibble. Roper Manufacturing Co. had a contract to equip a fleet of jeeps for shipment abroad, and the Cannon digger was the accessory they were looking for. Cannon didn't get rich (on this invention, anyway), but he did clear several thousand dollars in royalties.

Another way is to set up your own business

The biggest returns (and risks) await the inventor who goes into business for himself.

Dr. David Richman gave up dentistry (after an automobile accident) to sell plastic swimming pools in Florida. Then he contrived a gun that sprayed fiber-glass onto pools, boats, and molds. Two years ago he set up shop in a concrete-block building in Hialeah, investing \$3,000 of his own money and raising \$10,000 in small bites.

The gun is an efficient tool. Dr. Richman is a powerful salesman. He sold 100 units. At around \$4,000 each, that's good enough to interest Wall Street. Now the underwriters have floated \$250,000 worth of stock to enable Spray-Bilt Inc. to expand its business. Dr. Richman's original \$3,000 stake is worth close to \$100,000, on paper anyway.

Only a going concern can expand by selling stock to the public. You have to get started on money raised privately.

Maxwell Mangold, the chunky, fast-talking Wall Streeter who set up Spray-Bilt's stock issue, explains where to find that dough. Look to lawyers and accountants, he advises. They can introduce you to well-heeled citizens.

Why investment dollars sometimes come easy

The fat cats are ready and eager to ante up because of the way the Federal

income-tax laws are rigged. Uncle Sam plays heads-I-win-tails-you-lose with high-bracket taxpayers—and willingly takes the short end.

Take Mr. Gotrocks who earns so much money he is in the 80-percent tax bracket. If he socks \$10,000 of income in the bank, Internal Revenue will demand \$8,000 of that nice round sum.

Suppose instead he invests the 10 grand in your invention. Maybe the invention, a power-operated buggy whip, proves not very commercial. Old Gotrocks deducts this \$10,000 loss from his tax return—and is out of pocket only \$2,000.

But the sweet part appears if your invention is a never-dulling razor blade, and really takes off. Gotrocks' investment could easily double in value. His \$10,000 profit would be a capital gain, taxed at only 25 percent. Now he can keep \$7,500. This deal works fine for everybody: The inventor gets capital, the Government covers most of the losses, and the investor gets to keep most of his profits.

How much can you make if you're lucky?

Bendix paid \$649,000 plus a percentage for James Rand's patents on the Economat washing machine (the one that squeezes clothes inside a plastic bag). Only an old pro like Rand can drive that kind of bargain; ironically, the machine never caught on, and Bendix later sold out its appliance business.

A more realistic deal is an initial payment—often \$500 to \$1,000—against a royalty of three to five percent (on selling price).

If you beat the bushes for backing for a company of your own, you quickly find out that it won't be your personal company. The investors and their managers expect an 80- to 90-percent share of the new firm. They take a big risk, and shoulder 80 to 90 percent of the responsibility for ultimate success.

The inventor's cut may seem small, but it can turn out to be a nourishing slice. George Nelson's piece of Stud-Welding Corp. was just 20 percent. Twenty percent of \$15,000,000 is \$3,000,000.

What's Coming in Outboard Motors

[Continued from page 130]

jection and a turbosupercharger. Specific fuel consumption of the experimental power plant is .055 lb. per horsepower hour, better than that of most four-cycle engines.

Current outboard compression ratios are in the range of 6.5-6.7:1. Power could be increased by increasing compression ratios. This has not been done as it calls for far more flexible spark-plug heat ranges than present plugs offer; and it would also lead to detonation problems. Superchargers, however, will give better performance and fuel economy.

Outboard fuel injectors will probably be of the unit cartridge type. A bellows device will change metering automatically with variations in altitude, eliminating changes in jet size. Metering compensation for changes in temperature will be accomplished by the use of a bimetallic element.

Vari-pitch props. You can expect other changes besides those in the power head. Controllable-pitch propellers are coming,

to get maximum thrust under varying loads and conditions. Though a remotely operated controllable-pitch prop is complicated and expensive now, we should see them within the next five years.

Present control cables for throttles, shift, and some steering mechanisms lash around with motor movement. This leads to stiff operating, jamming, and breakage. Simplified disconnect linkages will be provided so that casings of push-pull controls will remain stationary regardless of power-head movement. We can look, too, for the power heads on big motors to become fixed with only the lower unit pivoting for power steering.

Remotely operated hydraulic controls will be provided for both motor-angle and transom-height adjustments. Additional instrumentation is coming, too. Water-pressure pickup tubes will be cast into lower units, and speed-meter connections will be provided at the top of the power head. Engine heat indicators and tachometers will also be standard.

A Steam Turbine for the Savannah

[Continued from page 146]

Check all fittings for steam leaks and time the duration of the run—it should be close to half an hour.

You must add ballast to the ship before installing the power plant. Sheet lead—the type used for flashing and electrical work—is best because it can be placed flat on the bottom of the hull for maximum weight at the lowest point.

Cut a piece 6" wide by 22" long and trim it to fit the hull. Cement it in with auto body filler or other metallic cement. Next, fold about 2½ pounds of the lead into a block about 3" by 4" to substitute for the weight of the radio-control receiver we'll describe next month. Should you decide not to install the radio control, the weight can be cemented in permanently to keep the ship trim.

Make the trim test before permanently installing the parts. Place them in the hull, put on the superstructure, and try the ship in a bathtub or wading pool to see how it floats. Shift the boiler and the lead block forward or aft, if necessary, to make the ship float on its waterline. A slight list of the model can be corrected by placing a few ounces of lead on the

high side to balance the hull properly.

When you get the ship riding level and at the right height, mark the position of the power-plant parts and the lead weight and return to the bench.

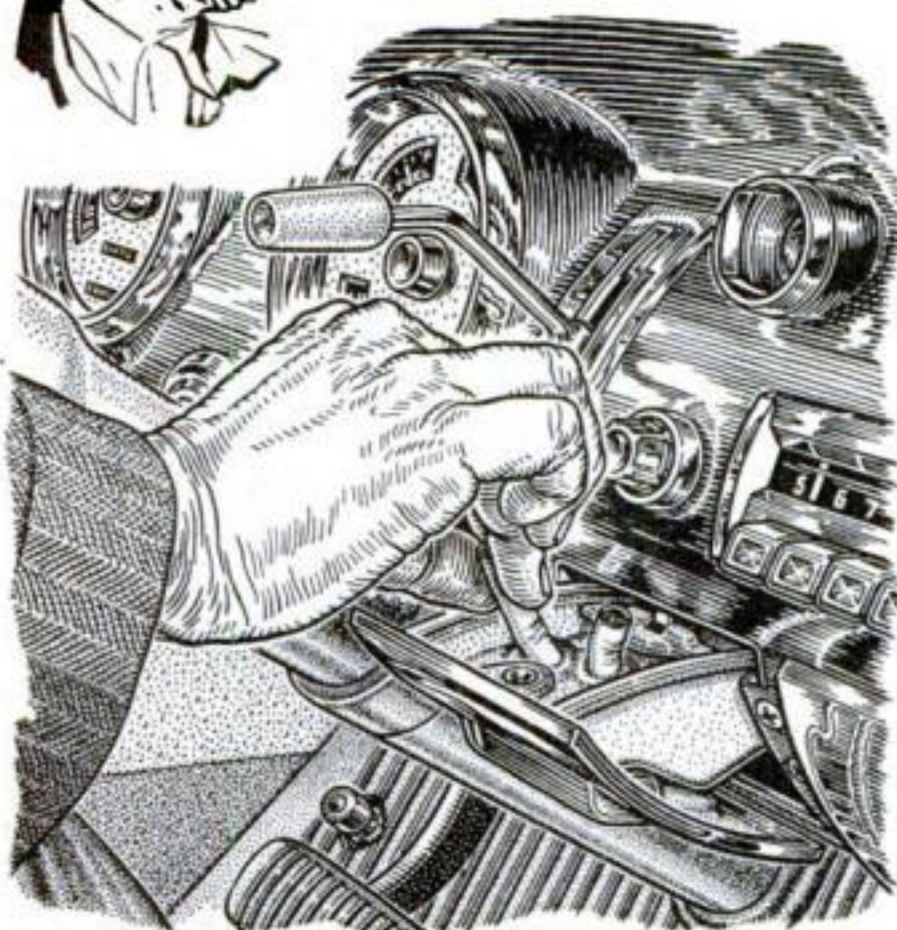
Cement ½"-square strips of wood across the hull bottom to support the boiler and gear-reduction unit. When the cement sets, screw these parts in place. The lead blocks can be fastened in position temporarily with masking tape. An effective flexible coupling between the gear output shaft and the propeller shaft can be made by soldering two collars on a close-wound coil spring about ¼" in diameter. Fasten the coupling to the shafts with a setscrew in each collar.

If the ship rolls or the water is rough, plug the lower row of portholes with putty to keep water out.

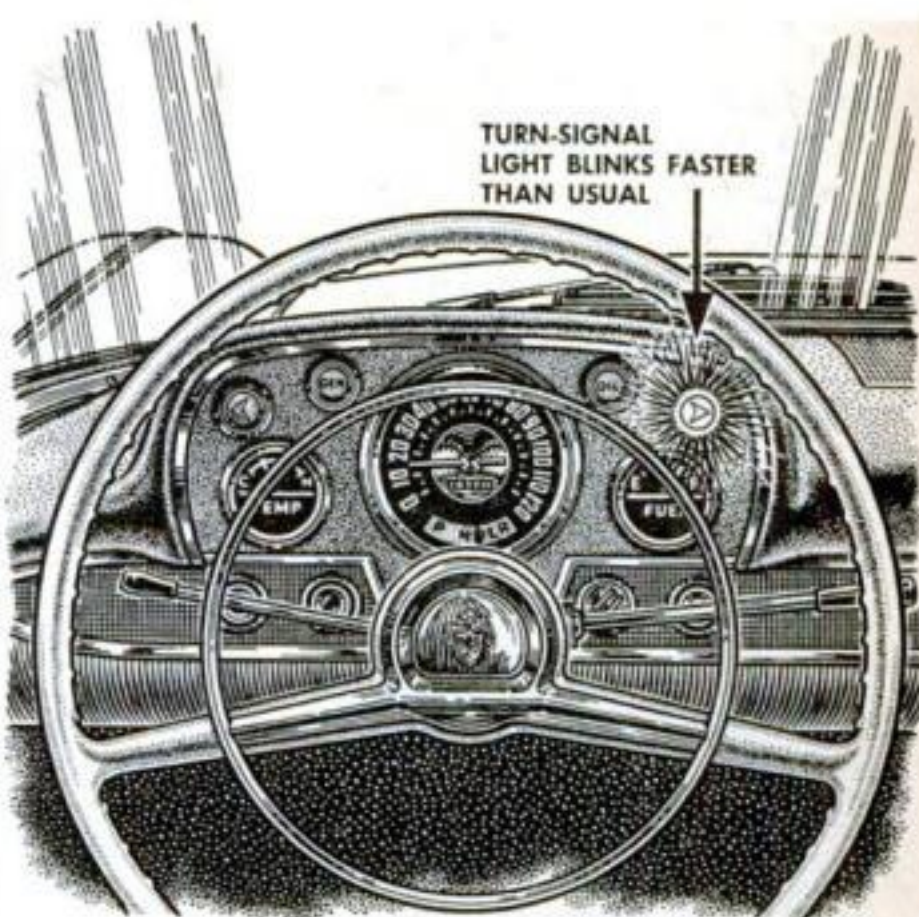
Lock the reverse idler in forward position and center the rudder to run point-to-point trips across a pond or pool. Seeing the model cutting a wake under her own steam is a sight to behold, but the big thrill comes next month when, by radio control from shore, you really take over as captain.



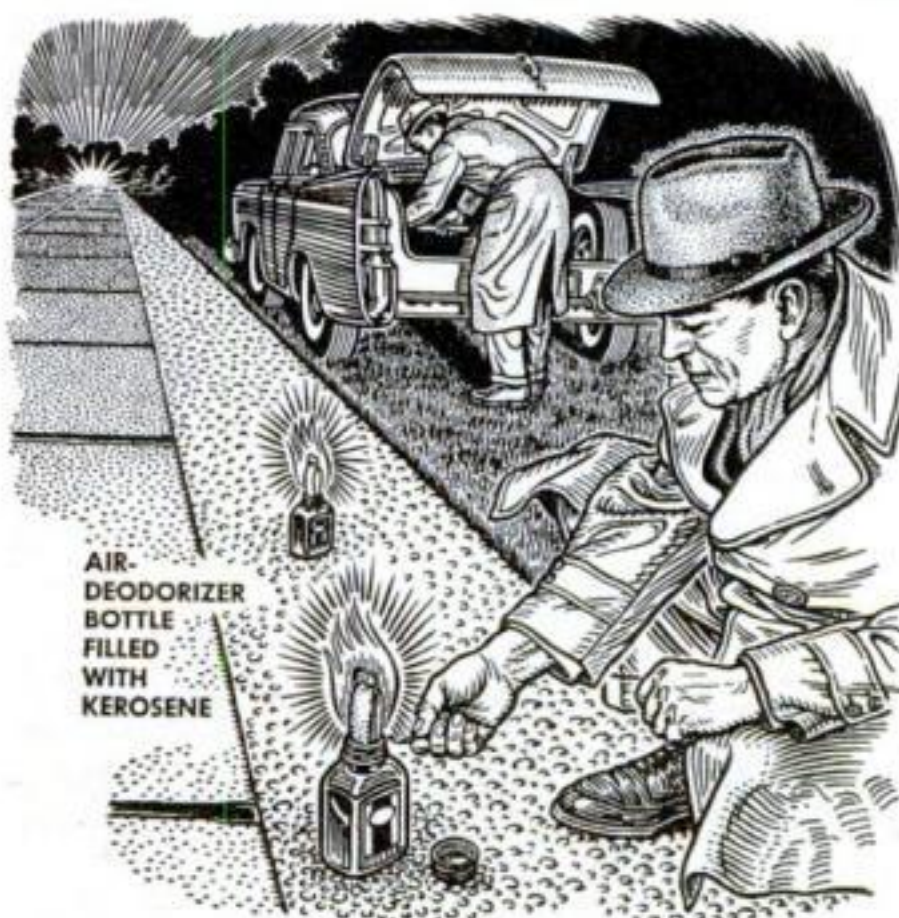
Hints from the Model Garage



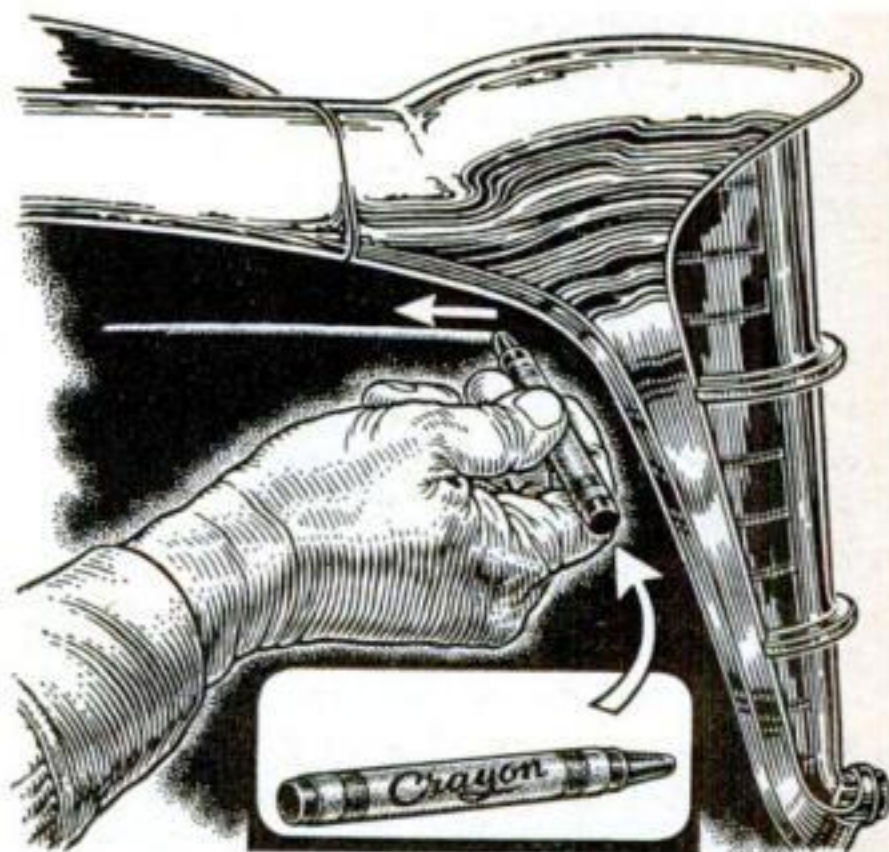
Snuff out cigarette butts safely, without taking your eyes off the road, this way: Put about $\frac{3}{4}$ " of sand in the ash tray. A butt will be smothered quickly when pressed into the sand, and it can't ignite other butts in the tray.



Turn indicator blinking too fast? Check your bulbs. An indicator light that blinks more rapidly than usual is the tip-off that a bulb on that side has gone out. Replacing the bad bulb will restore the indicator to its normal blinking frequency.

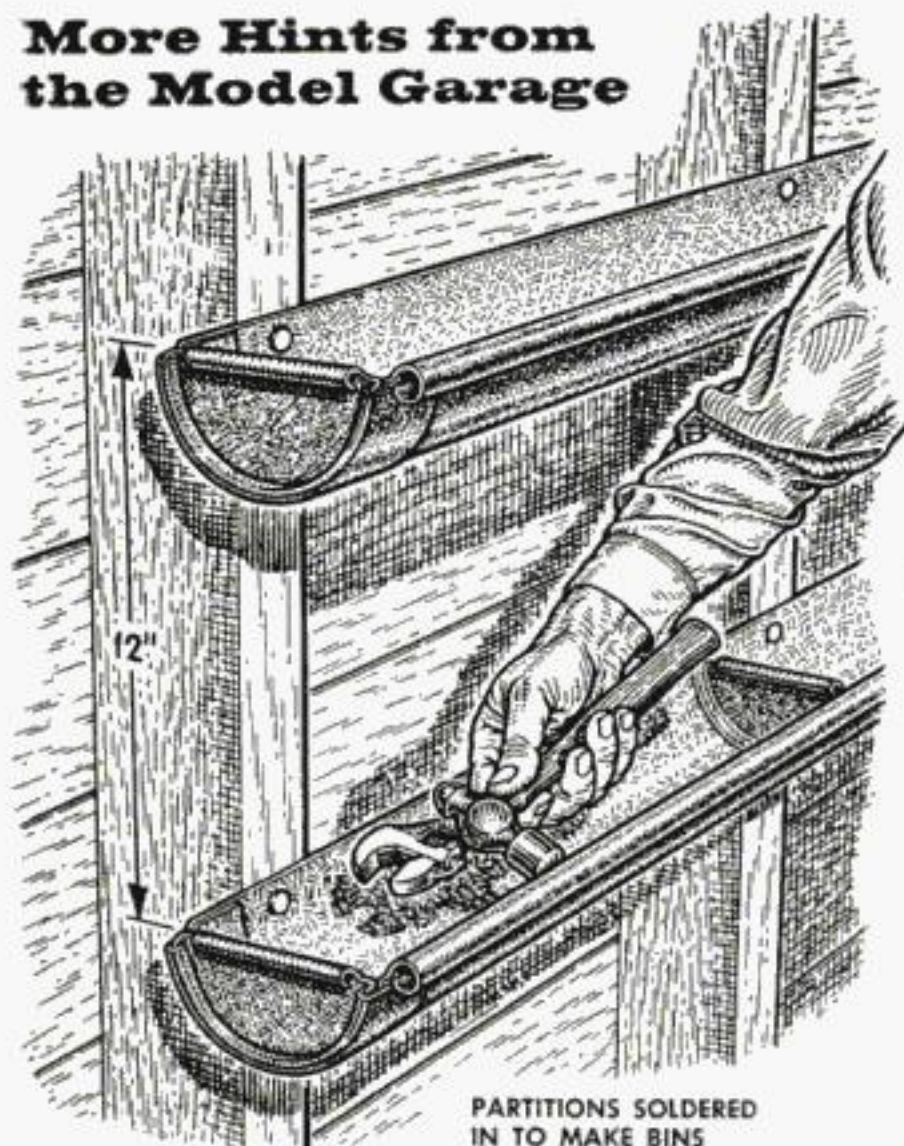


Long-burning road flares can be made by filling empty wick-type room deodorizer bottles with kerosene. When needed, unscrew the cap, pull out the wick, and light. Tightly capped bottles can be carried safely in a box in the trunk.

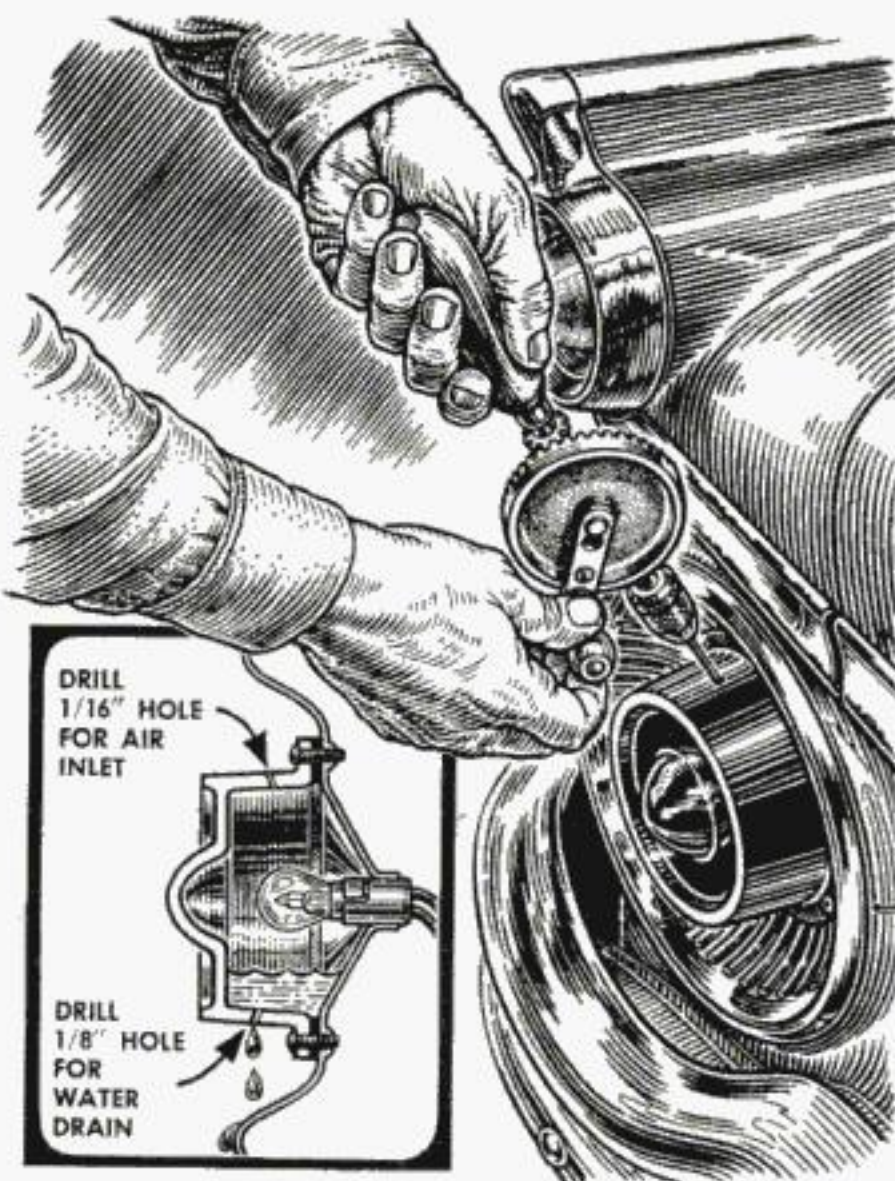


Touch up small scratches or paint chips with a school crayon of matching color. Rub the crayon over the scratch until it is filled. Then polish the area with a soft cloth to blend the crayon wax in with the surrounding car finish.

More Hints from the Model Garage



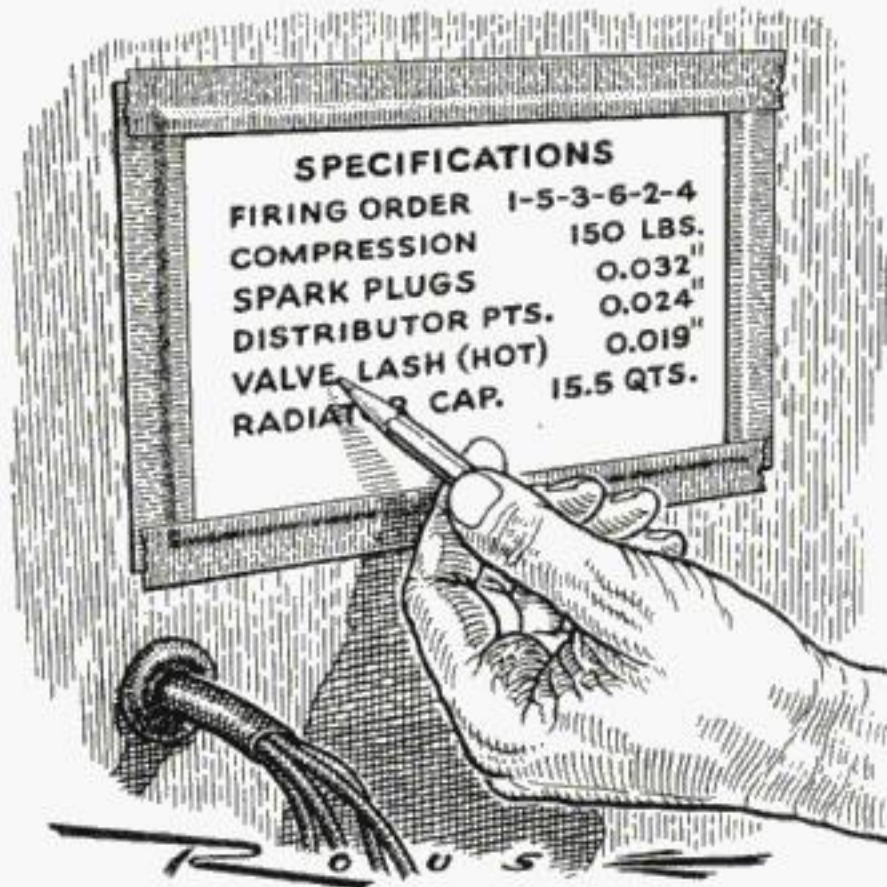
Handy storage bins for nails, screws, and small tools can be made from aluminum or galvanized steel gutters. Nail the gutters to the wall, one above the other. Use metal end caps to close the ends and to form partitions between the bins.



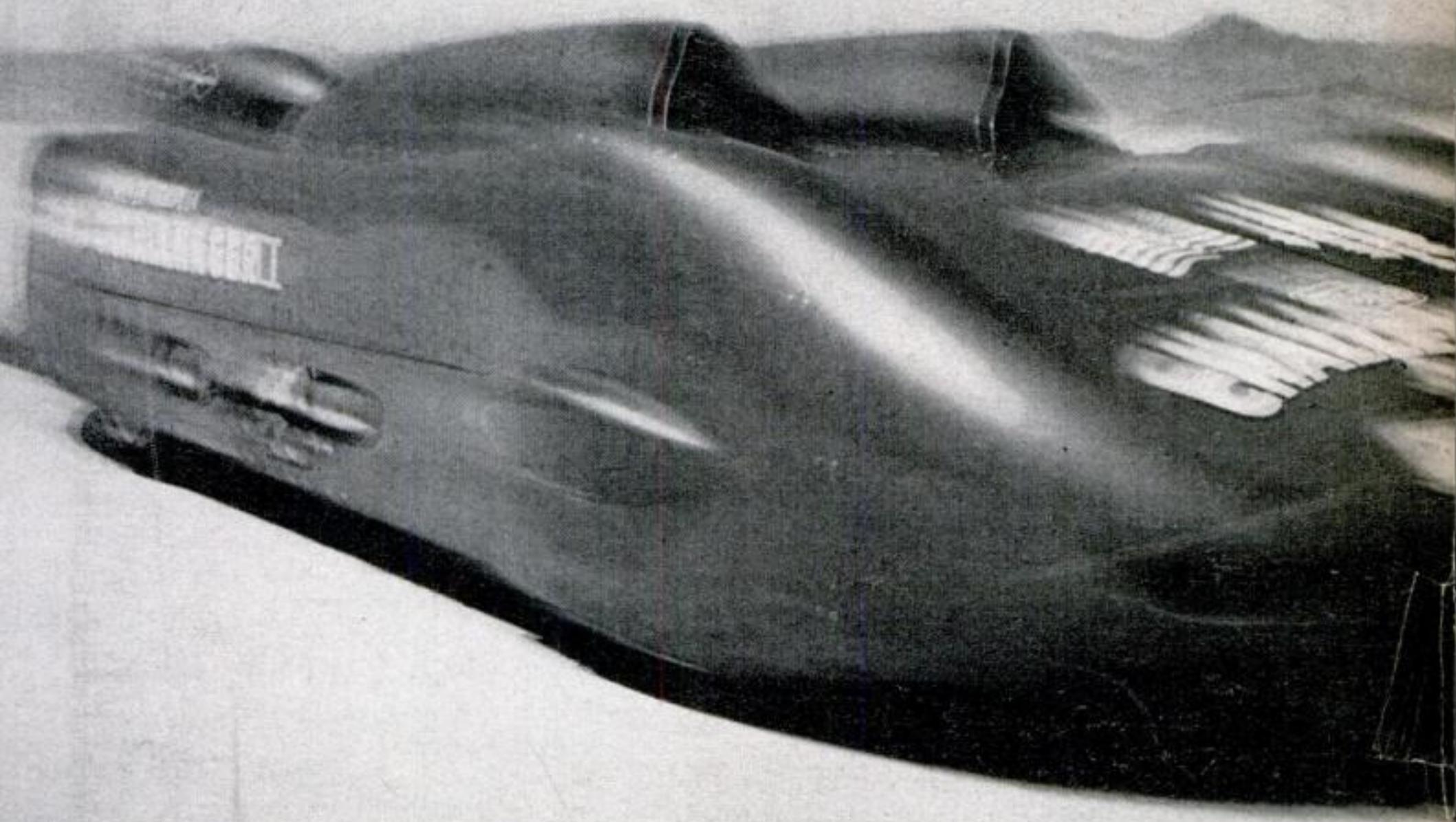
Rain water often accumulates inside the big tail-light lenses on modern cars. Locating and sealing off the spot where water enters isn't easy, but providing a drain is. Just drill two holes, as shown above, to let water out and air in.



Windshield-washer solvent can be stored beside the washer reservoir by fastening a tin can inside the engine compartment with sheet-metal screws. A strip of sponge rubber slipped between the bottle and can will prevent annoying rattling.



To save going through the shop manual each time you tune up or adjust your car, type all basic specifications on a card, cover it with clear plastic, and tape it to the firewall. The information will be helpful to your repairman, too.



406.6 m.p.h.! Mickey Thompson sets a one-way land speed record at Bonneville in his Champion-sparked Challenger I

Spark your car with Champions— the plugs that powered the world's fastest car!



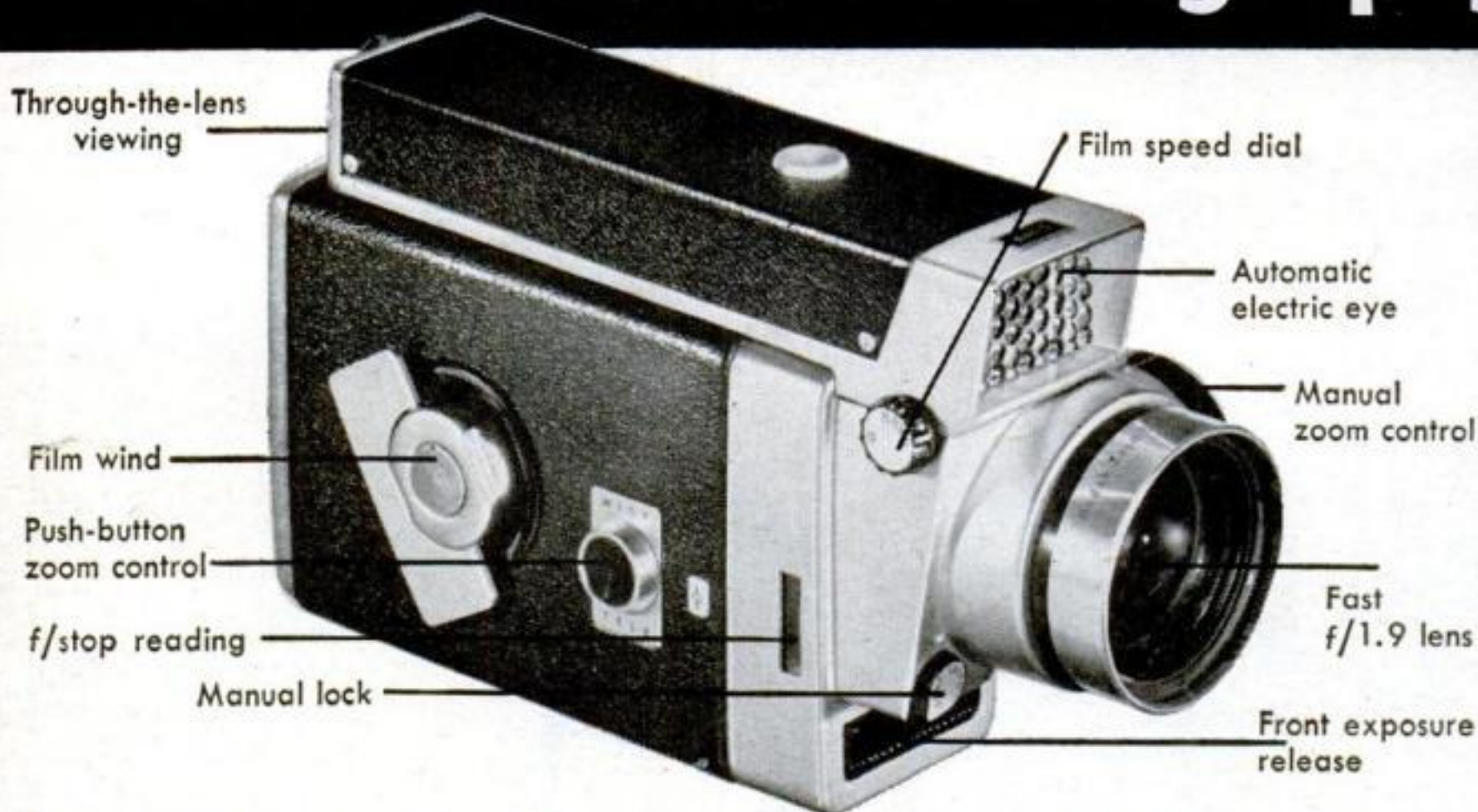
Over twice as many car makers specify Champions for top performance. Above: Champion-equipped Ford Thunderbird.

Men who shoot for new records know they have to squeeze every bit of performance out of their engines. They demand efficiency and full-firing power. That's why they choose Champion spark plugs. Put a new set of Champions in *your* car every 10,000 miles. They'll deliver all the performance built into your engine . . . and they'll save money on gasoline!



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New Ideas in Photography



New Electric-Eye Camera Lets You Make Zoom Effects with Push-Button Ease

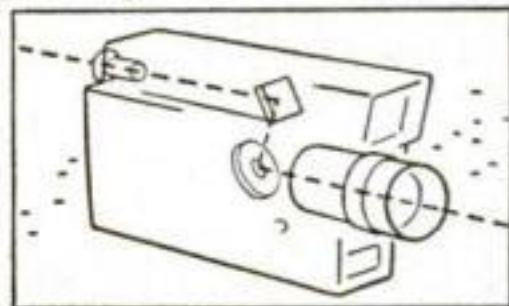
With the new Kodak Zoom 8 Reflex Camera, one button operates the camera *and* zooms the lens. Push down, and the lens zooms automatically for a screen-filling close-up. Push upward for a wide-angle view. Zoom in or back—not a second of action is lost. And you see it all, right in the viewfinder, just as it will appear on the screen.

This remarkable 8mm camera also lets you follow the action without stopping to adjust exposure. A built-in electric eye sets lens to changing light conditions automatically. For special lighting effects, you can lock the

meter at any indicated exposure that you wish.

Move in as close as 16 inches, using Portra Lens attachments. There's no "parallax error" since you view through the lens (*see the diagram*).

Priced at less than \$200, the Kodak Zoom 8 Reflex Camera (Automatic $f/1.9$) can be yours for as little as \$20 down. See your Kodak dealer for exact retail price.



New Kodak Sound 8 Projector—less than \$350

New Sound Projector Can Turn All 8mm Home Movies Into "Talkies."

Would you like to add voices, music, sound effects to your 8mm movies—old or new?

It's easy—with the new Kodak Sound 8 Projector. Have Kodak Sonotrack Coating added to your edited film. As you project this film, record your comments, using the microphone that comes with the Sound 8. To add music, connect your phonograph or tape recorder. Immediate playback. To make changes, merely re-record. Recording head is made of Alfenol, ultra-durable new alloy. Kodak Sound 8 Projector shows films at 16 or 24 fps.

from Kodak

One-Billionth Horsepower Controls Exposure in Automatic Cameras

Imagine a rating of $1/1,000,000,000$ horsepower. At Kodak, it's jokingly called "oatpower." Yet one "oatpower"—generated by the photocells of Kodak automatic cameras—insures correctly exposed snapshots, slides and movies.

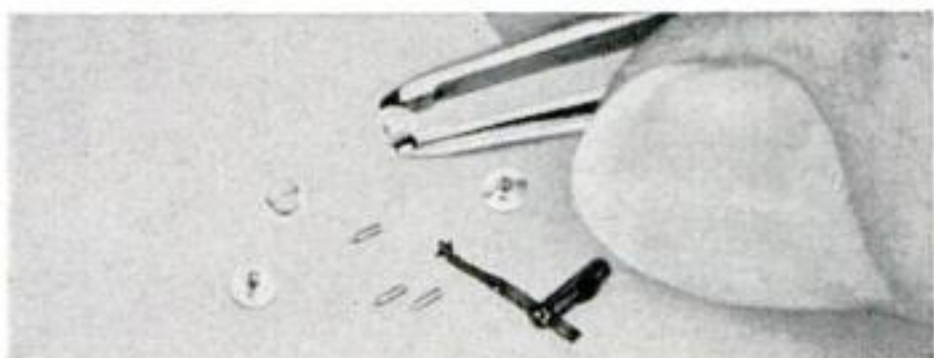
Each photocell is composed of a thin steel plate coated with layers of selenium, cadmium, and gold or platinum. The last layer is about one molecule thin, and is covered with lacquer to seal out moisture.

Works this way. When you aim a Kodak automatic camera, light from the scene falls on the photocell and is converted into electric current. This generates the power that operates the balanced meter mechanism.

The position of this mechanism determines the lens opening. On a sunny day, when you press the shutter release of a Kodak automatic still camera, the lens "squints." In the shade, the lens opens up.

With Kodak automatic movie cameras, the lens opening adjusts *continuously* to changing light conditions.

See your Kodak dealer. He can help you choose the automatic camera that best fits your needs from those shown at the right.



These bearing pins are from a Kodak electric-eye system. They have the same .001 points as the LP phono needle shown with them. So precisely balanced is the system that a human hair can be used to move the meter needle through its full range.

Picture it now . . . enjoy it again and again

EASTMAN KODAK COMPANY, Rochester 4, N. Y.

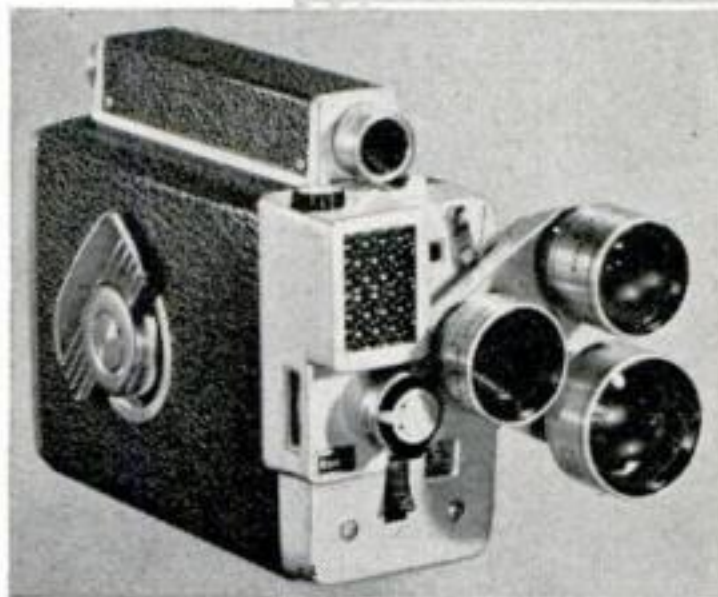
See Kodak's "Ed Sullivan Show" and "Adventures of Ozzie and Harriet"



Brownie Starmatic Camera, less than \$30.



Kodak Automatic 35 Camera, less than \$90.



Kodak Cine Automatic Turret Camera, f/1.9, less than \$125.



Brownie Automatic Movie Camera, f/2.3, less than \$78.

Prices are subject to change without notice.

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Bruce Laminated Oak Block

Modernize your home by installing this beautiful hardwood floor over your old floors. Or use low-cost Bruce Laminated Blocks to create new living space in attic, basement or addition.

Easy to lay — Just apply adhesive (Bruce Everbond Coldstik) and lay blocks. Tongues and grooves assure tight fit. No nailing . . . and no sanding or finishing either, because Bruce Laminated Blocks are completely prefinished at the factory. Your new floor is ready to be used and admired as soon as you lay it.

Moisture-resistant — Blocks are 9" square and only $\frac{1}{2}$ " thick. The three oak plies are laminated under heat and pressure with waterproof glue to prevent expansion and contraction. Ask your lumber dealer for a cost estimate. Mail coupon for color literature on Bruce Laminated Blocks.

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Address _____

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Answers to PS Puzzlers on 18 and 20

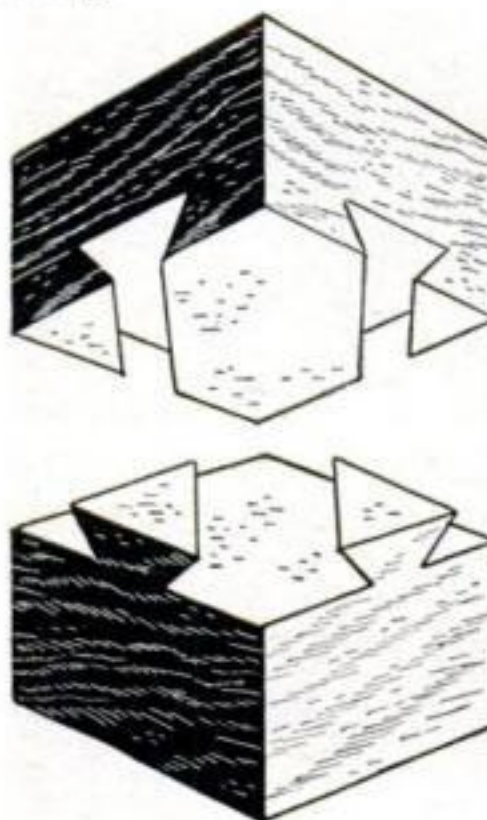
Pigs-in-sties. Put 8 pigs in the first sty, 10 in the second, nothing in the third, and 6 in the fourth. Ten is nearer 10 than 8; "nothing" is nearer 10 than 10; 6 is nearer 10 than nothing; and 8 is nearer 10 than 6.

Infinite snowflake. Yes—the curve length grows indefinitely. (Mathematically, its limit is infinite.) Here's what happens:

At the first step the curve was one unit long. But at step 2 we got four segments each $\frac{1}{3}$ unit long—a total of $\frac{4}{3}$ units. At step 3 we got 16 segments each $\frac{1}{9}$ unit long—a total of $\frac{16}{9}$ units long. It's easy to see that after 1, 2, 3 . . . n steps, the curve length is 1, $\frac{4}{3}$, $(\frac{4}{3})^2$. . . $(\frac{4}{3})^{n-1}$ units. Since $\frac{4}{3}$ is a number greater than 1 it's obvious that by choosing n large enough, the number $(\frac{4}{3})^{n-1}$ can be as big as we like. (It takes only 49 steps to get the curve length over a million units.)

No-pencil quickies: 1. Only four squares. 2. You're going to hate me for this: The answer is anywhere—except the poles—if you walk backwards. 3. The bat cost 75 cents, the ball 50 cents.

Woodworking:



The two pieces slide together diagonally as shown above.

Insure your boating pleasure three ways—with Weldwood



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WELDWOOD RESORCINOL GLUE**



**Prevent rot and warp with
WELDWOOD WOOD PRESERVATIVE**



**Protect your boat's beauty with
WELDWOOD SPAR VARNISH**

Once your boat's in the water, you don't want to spend time working to keep her afloat, you want to enjoy her. So give your boat the attention she needs now. These three marine products by Weldwood® can help you do the job better—and do it more easily. They're sold at leading marine and lumber, paint, and hardware dealers'.

WELDWOOD WATERPROOF RESORCINOL GLUE is best for *all* boat repairs, *essential* for any below-the-waterline gluing jobs (it's *guaranteed* waterproof). Makes a powerful bond, resists fungus, rot, heat, oils. From \$1.15.

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How the dip-stick spots engine trouble!

Does the dip-stick in your engine crank-case show up costly oil loss?

If it does, better have an experienced engine mechanic check your engine for bearing wear.

More than likely, he'll find that dropping oil levels on the stick are linked to poor engine performance. And here's why: once bearings wear beyond the engineered clearance point, oil pressures drop. Surplus oil splash goes wild. Uniform lubrication is lost. Excessive oil flies onto the cylinder walls. It is pumped into the combustion chamber where it burns into carbon. It fouls plugs. Deposits pile up on valves and piston rings. Rings cease to flex and menace compression.

Your mechanic knows the best method of correcting these troubles. You'll find in most cases he'll suggest Federal-Mogul engine bearing replacements to restore perfect performance.

Federal-Mogul engine bearings are the world's standard for quality. And world-wide distribution brings them as close as "next door" for leading imported and domestic car engine replacements.



FEDERAL-MOGUL SERVICE



Division of Federal-Mogul-Bower Bearings, Inc. • Detroit 13, Michigan

New Gas Furnaces

[Continued from page 83]

The advantages of thermoelectric systems are clear. They can be smaller, more efficient, easier to install. (No separate electrical wiring is needed.) They have built-in reliability for emergency, too: They'll work when the power lines are down.

Infrared ceramics. The furnace that could make pools usable all year round—or eliminate the need for snowshoveling your driveway—is the Schwank Infra-Red Heater, sold by the Perfection Division of the Hupp Co., Cleveland. It is already in use in factories, foundries, and outdoor restaurants. Now smaller ones are available for homes. While the Schwank burner also heats by radiation, it differs sharply from the Pyrocore. Here it's the ceramic that counts. A powerful gas producer of infrared energy, the ceramic lines one side of the burner in a $\frac{3}{8}$ -inch-thick plate.

Honeycombing the plate are tiny holes (200 per square inch), which allow the gas-air mix to flow through and burn on the surface of the plate. At red-hot temperatures the ceramic then emits infrared rays. Because the ceramic itself is a poor conductor, little heat is lost to the back of the burner.

The large air-hole area has an extra use, too: So little back pressure is built up that the burner can use air at ordinary atmospheric pressure. No compression (as in the Pyrocore) is necessary. But—efficiency is not as high.

The gas people have also been working to improve conventional heaters. So many new dodges have been tried in the past few years—and are panning out—that experts advise looking for equipment that now has (or soon will have) such features as these:

- 1) Sealed combustion. Many of the conventional wall heaters offer burners and combustion chambers that are shut off from the room itself. The burners feed on outside air only, are cleaner, odorless, lint-free. The sealed combustion chambers allow long fingers of flame to travel safely, deliver more heat.

- 2) Direct vent. Many companies make wall heaters with intake and exhaust pipes built into the outside wall. With no need for chimneys, the units are easier to install, cheaper, more efficient. (No



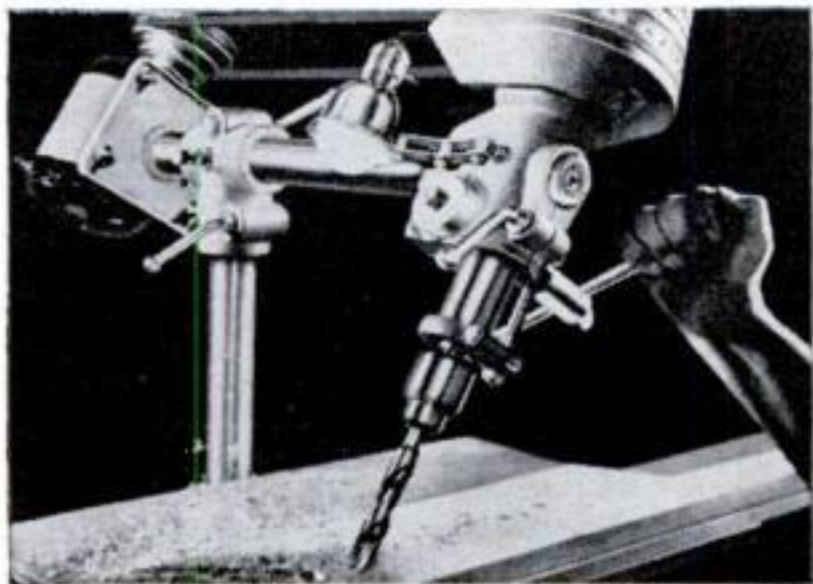
SHOP FULL OR SINGLE TOOL you can do more with DELTA

Every tool you choose for your workshop should deliver more than just extra capacity to handle your latest project idea.

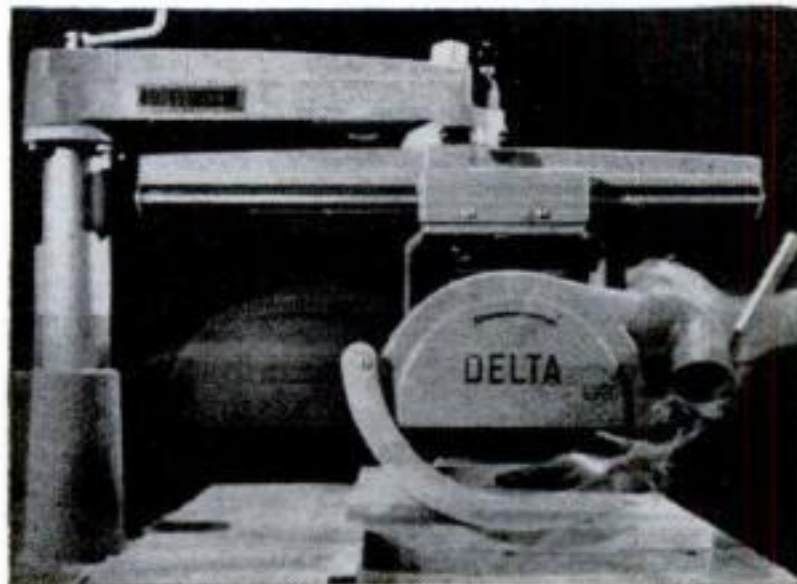
You'll want built-in precision you can rely on for years to come—versatility that extends the range of useful jobs you can do—advance engineering features to give you convenience and safety that can double your shop fun and

relaxation. Delta Power Tools give you these important advantages.

So whether your "dream shop" plans include a tool for every operation, or simply several basic tools equipped with low cost accessories to handle a wide variety of applications, plan now to see Delta tools. No other power tool line is more complete—or can help *you* do more.



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New Gas Furnaces

cold flue drafts, for one thing.) As progress in forced-draft burning continues, the newer units will be able to operate with almost miniaturized vents instead of the six- or eight-inch widths that are standard today.

3) Counterflow. Wall heaters made by Empire Stove Co., Belleville, Ill., draw return air in near the ceiling and deliver heated air near the floor. This is a reversal of the usual method of sucking in cold air at the floor. Not only does counterflow permit the warmed air to rise naturally, but it's also cheaper to heat the already warmed air fed in at the ceiling.

What lies ahead. Manufacturers and gas-utility researchers in the lab are studying the new combustion methods in earnest, testing the new ceramics or other radiant materials. They're also making tricky spark igniters using transistors and batteries that are recharged when the heater is operating. That work is part of the general plan to make gas appliances completely automatic, and independent of electrical wiring.

The American Gas Association has even come up with the industry's rival to electric baseboard heating: A gas-fired heater which, in its aluminum liner, could fit in the standard stud space of an outside wall. The heater's sealed burner feeds a continuous eight-foot flame through a 7/8-inch stainless-steel tube. Intake and exhaust pipes are both outside. The lab model is 80-percent efficient.

Prompted by military needs as well as consumer possibilities, the industry is also pressing research in thermoconversion—ways of turning heat directly into electricity.

One way to do it of course is with thermocouples. Another is with a thermionic generator, a device that boils electrons off a metal surface, and bonds them to a nearby (.001 inch) acceptor plate. Space scientists hope to use sun heat for such converters.

The researchers also hope to produce a cheap, reliable, reasonably efficient fuel cell—a gas-fueled battery that would work much like an ordinary wet cell, converting chemical energy to electrical energy permanently, or at least as long as it was fed the industry's choice commodity—gas.

The 30 hp. Bundy 500 is a new outboard motor that achieves a new standard of compact simplicity, economy and performance. It was designed for you, the boating enthusiast with an above average sense of value. In one package the Bundy 500, the perfect family motor, gives you power to do any of the things you enjoy in boating.

DID YOU SAY POWER? *Compares to 35 hp. . . . plenty for waterskiing and sight-seeing cruises. And with twin Bundy motors, you have 60 hp. and double dependability.*

DID YOU SAY SLOW TROLL? *No need for that special trolling motor. The Bundy 500 will troll down with the smallest, just as steadily and economically. Unique oil-scavenging system prevents "loading-up" and "plug-fouling".*

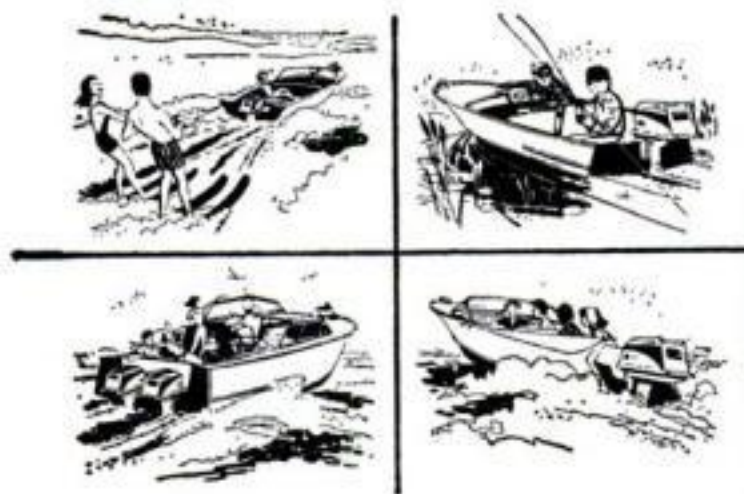
DID YOU SAY ECONOMY? *The Bundy 500 costs less initially and runs with the economy of a 25 hp. Others use up to 66% more fuel! You use regular gas and outboard oil for additional savings.*

DID YOU SAY QUIET? *The Bundy 500 is naturally quiet. Perfect balance and fit of parts give the Bundy the quiet hum of precision machinery.*

DID YOU SAY VALUE? *Styled by Ghia of Torino. Engineered by Innocenti. Manufactured by Italian craftsmen for American boatmen. Weighs approximately 1/3 less than others in its power range. Includes electric and manual starting. Magnetic Alternator recharges battery. Ingeniously simple for quick, low-cost service. The finest quality outboard engine available anywhere today. Fully warranted. Available in limited quantities through select marine dealers.*

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Just connect the ESB ACTIVERter to a battery and you can have 110 AC instantly, anywhere, for many hours. You can plug in portable electric power tools, an electric blanket, electric lights, even a television set! A flick of a switch and the ESB ACTIVERter fast or slow charges 6 or 12 Volt batteries.

Compact, Rugged, Truly Portable

The compactness of the ESB ACTIVERter design makes it possible to have a 12 Volt storage battery, an inverter, and a battery charger all in one self-contained and portable package. One PAK-O-POWER ACTIVERter model provides a source of 110 Volt AC, with an output rating of 500 Watts, in a package the size of a portable picnic cooler! Because solid-state electronic components are used throughout, ACTIVERters are both rugged and lightweight. There are no moving parts, no vibrators.



4 Sizes—from 150 to 500 Watts

MODEL I-152 INVERTER—Inverter only, operates from direct connection to 12 Volt battery or through cigarette lighter socket of cars with 12 Volt systems. Output ratings: Intermittent Use—150 Watts, 1.5 Amps. AC... Continuous Use—125 Watts, 1.2 Amps. AC. Shipping Weight: 8 lbs.

MODEL IC-252 ACTIVERter—Inverter-Charger operates from direct connection to 12 Volt battery. Output ratings: Intermittent Use—250 Watts, 2.3 Amps. AC... Continuous Use—200 Watts, 1.8 Amps. AC. Shipping Weight: 15 lbs.

MODEL IC-202P PAK-O-POWER—Inverter-Charger with compartment for 12 Volt battery. Completely self-contained unit. Output ratings: Intermittent Use—250 Watts, 2.3 Amps. AC... Continuous Use—200 Watts, 1.8 Amps. AC. Shipping Weight less battery: 22 lbs.

MODEL IC-506S PAK-O-POWER—The Multi-Service Inverter-Charger-Car Start unit, with large 12 Volt battery compartment and Car Start leads. Completely self-contained with built-in fast and slow charger—Charging rate: 60 Amps. for 6 Volt, and 40 Amps. for 12 Volt batteries. Output ratings: Intermittent Use—500 Watts, 4.0 Amps. AC... Continuous Use—300 Watts, 2.5 Amps. AC. Shipping Weight less battery: 55 lbs.

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10,000 Miles in a Tempest

[Continued from page 91]

fuel tank—the Tempest holds 15½ gallons. But careless gauge calibration—it showed zero with almost five gallons aboard—enhanced the illusion of a small tank.

Fermoyle complained about rain leaks, Allaway about the trigger-release parking brake, and the one-piece tailgate that forbids handling long loads.

After these bleats, as the staff termed its criticism of design and construction, the critics went on to praise.

For Fermoyle, “The engine ran like a clock.” Markovich liked the layout of the engine compartment, “Except,” he said, “for the voltage regulator, mounted on the firewall where it could short out in heavy rain.” He found entrance and exit easy.

For Mann, the Tempest was tight, quiet, and comfortable. Rowsome noted the car was not wind-sensitive. The tidiness of the rear-seat fold-down rig, and the extra underfloor luggage space, pleased him.

Safety and Comfort Features

Markovich had some second thoughts: “The dull-finished dash eliminates sun reflections. The heater is excellent. So is the all-around visibility. Hurrah for the manual choke!”

Fermoyle: “The big wheels help smooth out deep holes.”

A plus for that gearshift that roused Mann’s ire: “It’s crisp and sure.”

Allaway put it straight for the staff: “Handsomest of all the compacts.”

Summing Up

Rowsome: “Despite all demurrers, you have to look at this car in its context—a four-cylinder engine, lots of room, and at a price hundreds of dollars below that of the ‘big’ station wagons.

“Our beefs might well be washed out in Tempests in other configurations—a sedan body, an automatic transmission, the optional hop-ups of the four, or, indeed, the optional V-8.”

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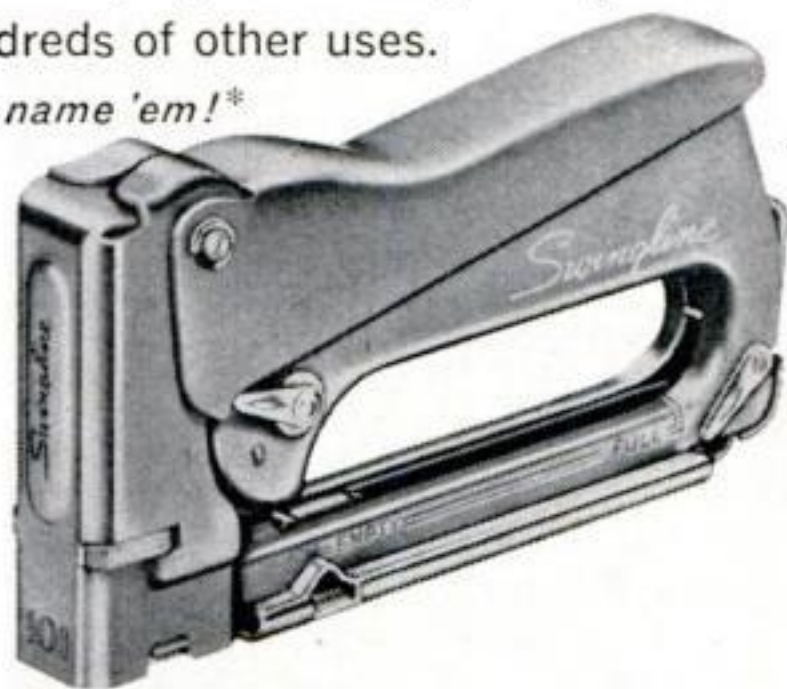


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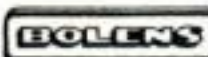
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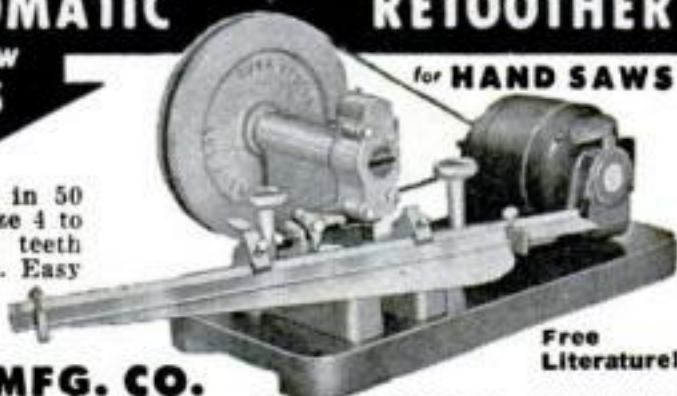
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What Steel Is That?

[Continued from page 180]

"Back there at the blast furnace," Dutch went on, "your hot iron picked up carbon from the coke and dissolved it, as water dissolves sugar. There's about four percent carbon in cast iron, making it crystalline and brittle."

"What about steel?"

"I'm coming to that. Suppose you put your cast iron in another furnace and burn out the carbon. Throwing in some iron oxide does it, or you can speed the process by bubbling compressed oxygen up through the metal. The impurities in the iron combine chemically with the slag, and when you run out the batch it's relatively carbon-free iron. Just a trace left in it—about one-tenth of one percent. That's mild steel."

"How about tool steel?" I asked.

"Simply add some carbon to your mild steel. Melt it up again and toss in a little ground anthracite, maybe, or a small piece of cast iron. Say you want some steel for cold chisels; then you increase the carbon content to eight-tenths of one percent—80-point steel, that is. Up the steel to 130 points and you can make razor blades of it. But you don't want to go much higher than that. If you do, your steel will be almost as brittle as cast iron again."

Alloy steels. "While I'm at it," I asked, "why don't I stir in something to alloy it?"

"Alloy steels are a little tougher than plain carbon steels, and they're easier to harden."

"How come?"

"Because you can give them a slower quench. Plain carbon steels have to be quenched in water or brine in a hurry, to cool them fast enough to form hard carbides. Drastic quenching sets up strains in the metal that can warp or crack it. But if you use a steel with a little chrome or nickel in it, you can harden the tool in warm oil."

"I've read about 'oil-hardening steel' somewhere," I said.

Dutch nodded. "That's a definition for low-alloy steels, just as plain carbon steel is sometimes called water-hardening steel. Then there's another group of steels containing about four percent chrome called air-hardening steel. Just cooling in air hardens them."

What Steel Is That?

"Stainless steel is a chrome alloy, too, isn't it?"

"It's a high-alloy steel," Dutch said, "with anywhere from 11 to 27 percent chrome. Good enough for kitchen knives.

"Getting back to knives," I said, "you told me this ground stock of mine is low-alloy tool steel. Then I quench it in oil?"

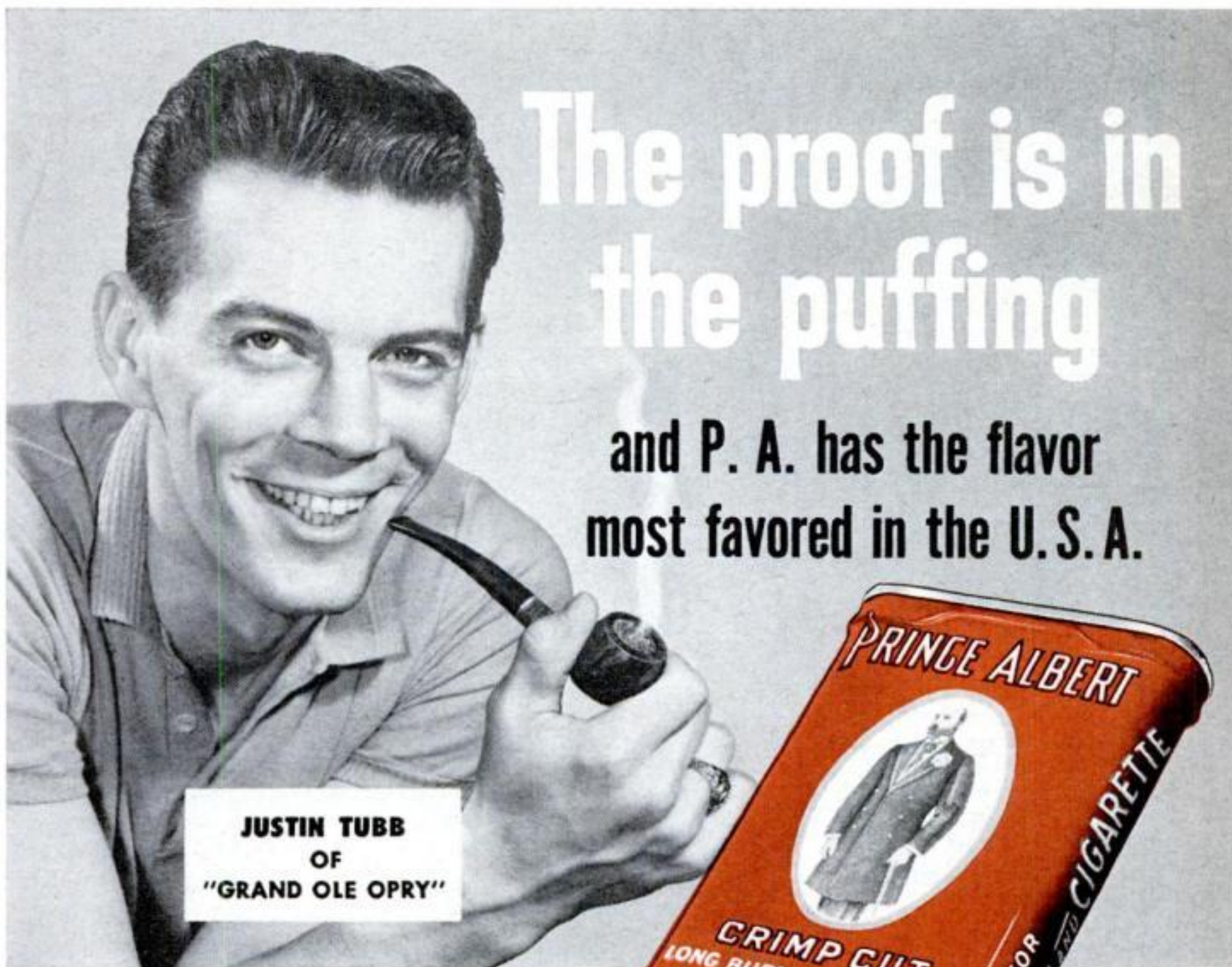
Oven-tempering. "You're learning fast," Dutch grinned. "It'll probably quench out file-hard. Then temper it at about 400 degrees to relieve strains in

the metal. Safest way is to put it in your kitchen oven for a couple of hours. If you use a torch it may get too hot."

While we'd been talking, Dutch had finished shaping the spring for his cookie cutter. Setting it on the backing plate, he flowed solder around the joint with his torch and trued the cutting edge on his sanding disk. We went upstairs and his wife looked it over approvingly.

"Thanks, dear," she said, "but what took you so long?"

My sheath knife turned out fine.



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O'Sullivan's Wonderful Lead Balloon

[Continued from page 77]

them on Mylar in layers far thinner than air-mail onion-skin paper. Then O'Sullivan heard a rumor that Reynolds Metals Co. had experimented with placing vaporized aluminum on plastic. That process did the trick.

One hour O'Sullivan was in his office at Langley Field, the next he was pacing through the laboratory or the shop; a few hours later he flew to Washington. He worked nights, weekends; he pushed his men; he prodded them with buckshot rounds of ideas; he kept government support alive; he demanded that industry provide solutions to problems it thought unsolvable.

How can you find a way to fold a perfect sphere so it can be expanded in a hurry without the single locking fold that would cause it to tear? Harassed by O'Sullivan, men who couldn't fold a road map properly found a way to fold his aluminum balloon.

How do you inflate the balloon? A jigger of air would expand so fast at the edge of space it would blow the satellite apart. When the satellite was shot out of the container, just enough gas had to form inside to inflate it—not too fast and not too slowly. They tried water, beer, dozens of strange chemicals before they discovered the right combination of sublimating powders that would turn to gas under the temperatures hundreds of miles up.

Building a satellite, however, was only part of the job. It had to be tested. Vacuum tanks were designed for the job. When O'Sullivan couldn't see what happened inside, he had a pressureproof porthole built in the side. The eye couldn't follow the sudden explosion of the balloon, so he ordered high-speed strobe-light pictures taken. Normal floodlights burst in the vacuum, so then a new lighting rig had to be created.

At last O'Sullivan thought his work was finished. He had built a 30-inch satellite that could be squeezed into the cranny he was assigned on a Vanguard. But the rocket wasn't ready to be fired. Months passed while the Vanguard project languished.

Instead of quitting, O'Sullivan impatiently started campaigning for a 12-foot inflatable satellite—something the whole

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world could see traveling in space. O'Sullivan armed himself with three major weapons of persuasion: facts, working models, and conviction. "You don't just tell people what ought to be done," he explains. "You show them how you can do it."

Chances and failures. He fought his case right up to the White House, and with President Eisenhower's initials on his proposal, the 12-foot inflatable satellite was loaded into a Jupiter C nose cone on Oct. 22, 1958. The rocket failed to put the satellite into orbit. Now O'Sullivan's 30-inch inflatable sphere was fitted into the nose cone of a Vanguard at Cape Canaveral, the launch button was pushed, and the rocket dribbled into the Atlantic. His satellite never had a chance.

O'Sullivan was well on the way to what one scientist called "suffering the highest failure rate of any scientist in the satellite field." The failures were not his fault, but each missed chance to put the satellite into orbit might be O'Sullivan's last opportunity. White House approval was necessary to get space on a Juno shot. O'Sullivan got it. Juno II carried another 12-foot inflatable satellite, and once more the rocket failed.

With each rocket failure O'Sullivan seemed to become more stubborn, more obsessed with his idea. He suffered smiles of amused sympathy and some open scorn in the scientific community. One day a colleague kidded him, "Now that you've failed with a 30-inch satellite and a 12-footer, what are you going to do—build a 100-foot one?"

"Yes," he answered seriously. "I am going to do just that."

In fact, work had already begun on a huge satellite, 100 feet in diameter. It would be used to test the theory of Dr. J. R. Pierce of Bell Laboratories, Inc., that signals bounced off passive reflectors in space could provide global telephone and television communications.

Testing a 10-story satellite. O'Sullivan was faced with a new problem—a 10-story-high satellite would have to be tested at the edge of space, for no vacuum tank big enough could be built. A rocket called Shot-Put was designed to do the job.

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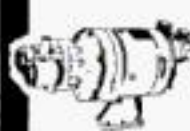
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Wallops Island the firing went well, but far up in the air hundreds of sparkling pieces of aluminized plastic were blown out of the inflated satellite and formed a cloud that glinted in the sunset. Something had gone wrong, and the failure was hardly a private one—the Fourth of July display was seen from Canada to Florida, and the NASA was flooded by thousands of worried phone calls.

Now G. T. Schjeldahl Company of Northfield, Minn., experts in building high-altitude weather balloons, took over construction of the satellite and in six weeks invented a new system of taping the balloon's seams that made them as tough as its 82 panels.

Another test rocket was launched in January, 1960. The second stage didn't fire. A month later the rocket fired properly, but the test satellite tore. Another rocket was only partially successful, for the satellite carried no tracking beacons. Nevertheless, O'Sullivan figured they were over the hump. Now he had a satellite that could be packed in the nose of a Thor-Delta rocket and placed in orbit 1,000 miles above the earth.

The satellite, called Echo, was a miracle of construction. The 31,500-square-foot surface of Mylar was covered smoothly on both sides with only four pounds of aluminum. It was folded into a sphere 26 1/2 inches in diameter. The entire satellite, including the 20 pounds of chemicals to inflate it and two 11-ounce radio-tracking beacons 3/8 inch thick but packed with 70 solar cells and 5 storage batteries, weighed only 132 pounds. On May 13 it was packed in a Thor-Delta.

O'Sullivan drank gallons of coffee, chain-smoked pack after pack of cigarettes, and tried, unsuccessfully, not to worry during the countdown of the Thor-Delta. Finally, the news came like a blow to the stomach: The rocket had failed.

Doggedly, O'Sullivan fought for another try. More memos flew out of Langley. He had strong arguments to answer, and seven failures, even if most of them were not his fault, made him vulnerable. On the last day of May, a fully successful Shot-Put test was completed. But still many authorities were unconvinced.

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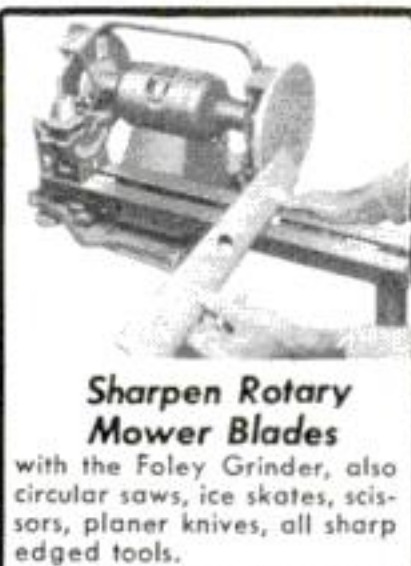
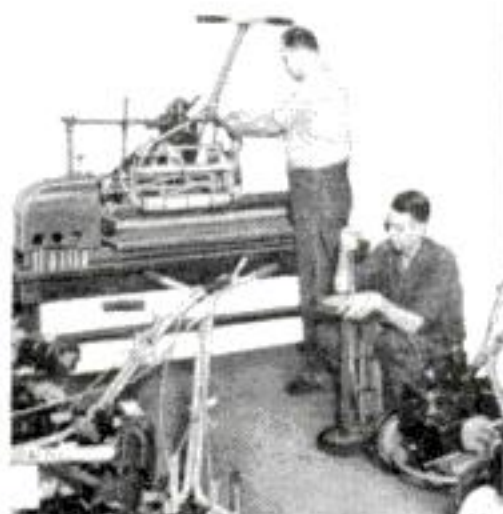
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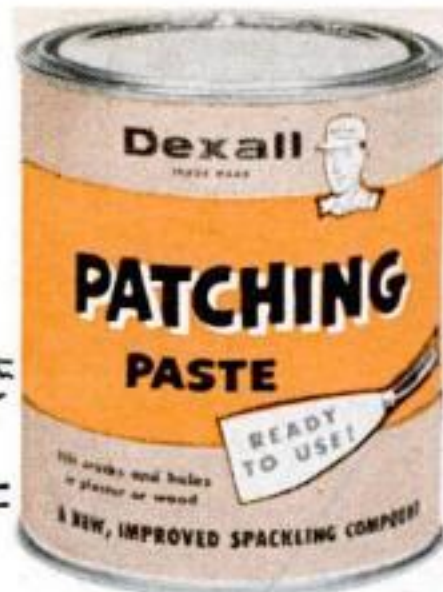
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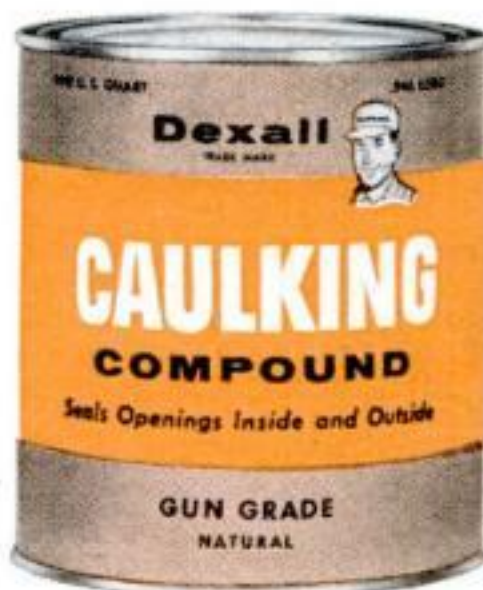
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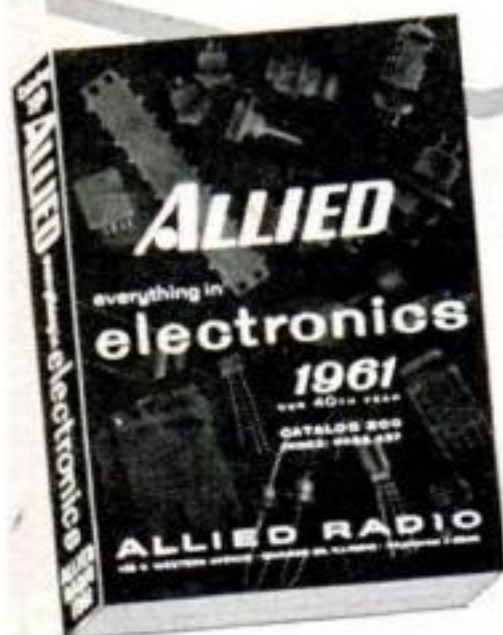
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O'Sullivan's Wonderful Lead Balloon
tured so many times by cosmic dust hitting the thin plastic at 100,000 miles an hour, that it would be destroyed within hours.

O'Sullivan refused to be talked out of his project. Finally, on Aug. 12, 1960, he had another 100-foot balloon packed into the nose cone of a 92-foot-high Thor-Delta rocket at Cape Canaveral. At 5:39 a.m. it was blasted into the sky. Minutes later Echo I was inflated perfectly, and at 7:41 a recorded message was shot aloft in California and bounced off Echo I to a Bell Laboratory receiver in New Jersey as the satellite passed over the United States.

"This is President Eisenhower speaking," the voice from space said clearly. "This is one more significant step in the United States' program of space research and exploration. The program is being carried forward vigorously by the United States for peaceful purposes. The satellite balloon, which has reflected these words, may be used freely by any nation for similar experiments in its own interest."

Echo I proved the cosmic-dust experts wrong. There just weren't as many micrometeorites up there as they had guessed. The satellite measured the air density and confirmed the scientists' theories that our atmosphere, although thin, still exists 1,000 miles above the earth. O'Sullivan's light, sensitive satellite has further revealed that the pressure of sunlight is strong enough to push Echo I about 60 miles closer to the earth in a month.

For all the world to see. The satellite has also been a significant propaganda weapon for the United States, for people all over the world can look up and see the evidence of our exploration of space with their own eyes.

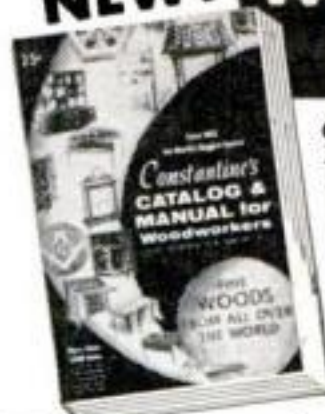
Today Bill O'Sullivan and his Space Vehicle Group have working models of sausage-shaped space stations, weird space antennas, even monstrous kites and gliders, all inflatable in space. He has chemists trying to find ways of using a plastic spray to stiffen a space vehicle once it is inflated. He has others exploring the possibility of creating plastic materials that might swell into a thick, steel-like girder when affected by solar radiation.

Perhaps O'Sullivan's most astonishing

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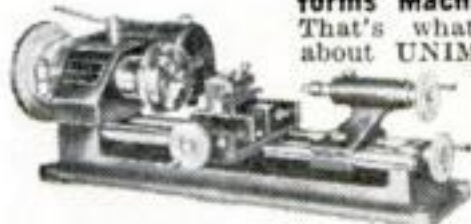
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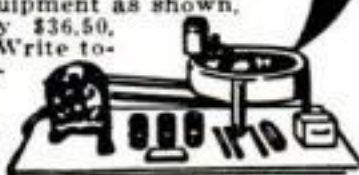
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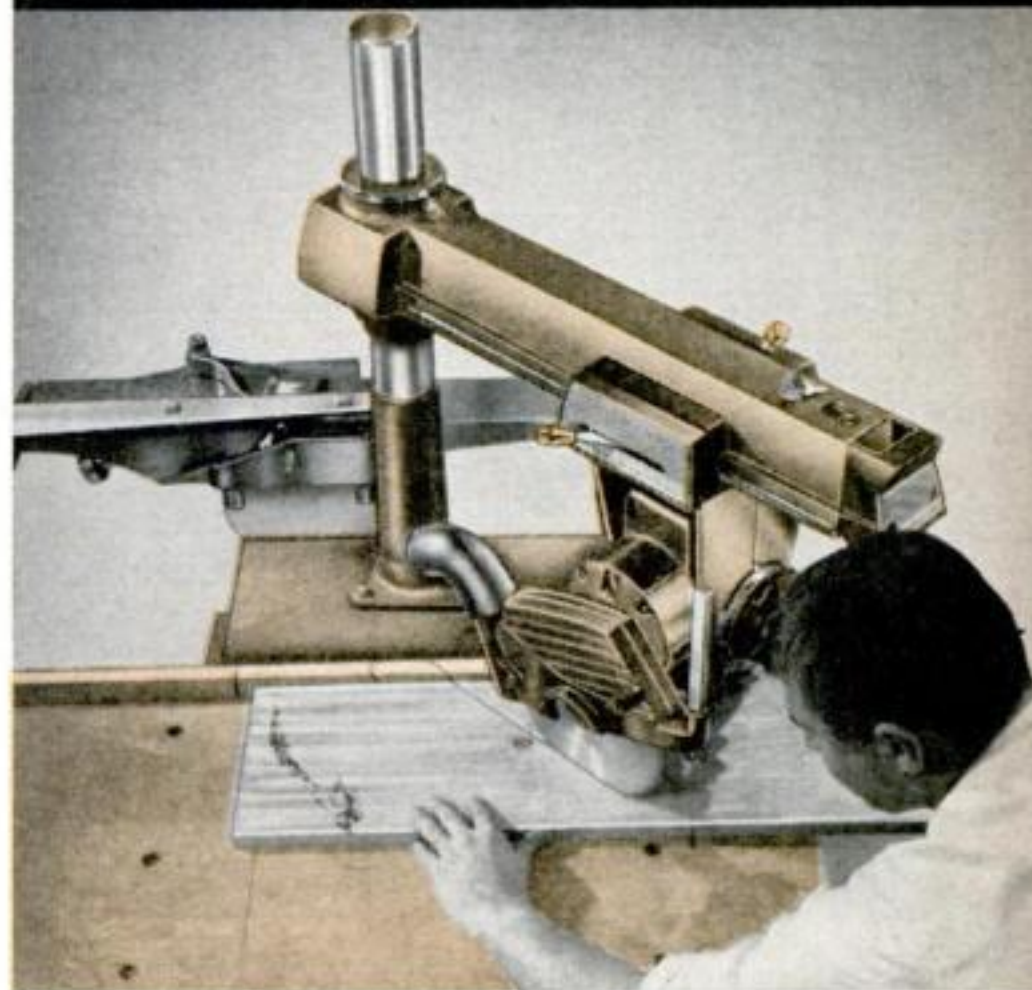
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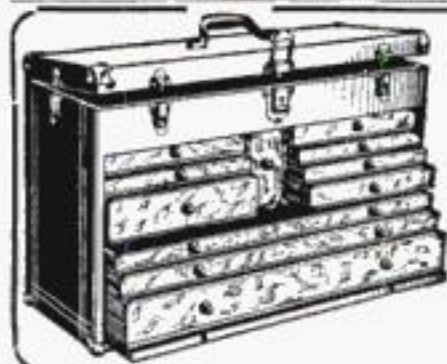
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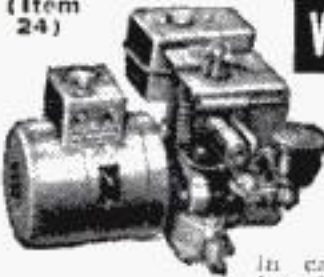


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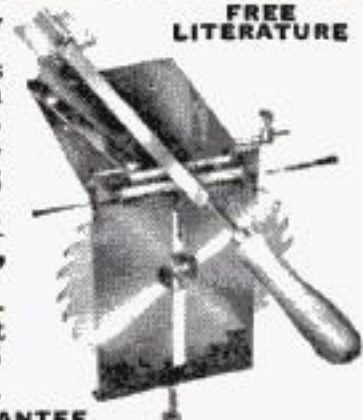


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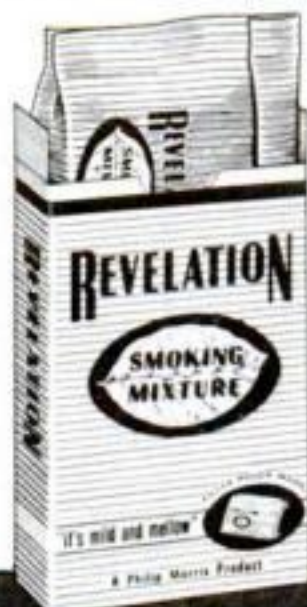
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**DOUBLE-LENGTH FEATURE OF
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The Violent and Mysterious End of Flight 2511

By Devon Francis



The Miami-bound airliner went down with 34 aboard and no survivors. Crash detectives pieced together a fantastic tale of terror in the sky—only to uncover a baffling new puzzle



EARLY on a January morning, a year ago, an airliner crashed near the rural community of Bolivia, N. C., carrying 34 persons—everyone aboard—to their deaths.

At the time it seemed only a momen-

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Captain of doomed plane: Dale H. Southard, 46. He had logged more than 16,000 hours' flying time as a pilot.

FLIGHT 2511, on that morning of January 6, had not been scheduled at all. Its passengers, along with 76 others, had been booked aboard a big jet transport from New York for Miami. Then a crack was discovered in a window on the jet. Putting in a new window would take eight hours.

The delayed and fretful passengers were marshaled aboard two other airplanes, neither having the jet's passenger capacity. One was an Electra turboprop, the other a DC-6B. Passengers boarded on a first-come, first-served basis. Seventy-six of them trooped into the Electra, the faster of the two planes. The remaining 29 took the DC-6—Flight 2511.

The DC-6 was a sturdy, trustworthy airplane, propelled by four 2,400-hp. piston engines. It cruised at a respectable 300 miles an hour at an altitude of 3½ miles. It had a crew of five, captained by Dale H. Southard, 46, an old-timer who had logged 16,000 hours as a pilot. He had flown more than half of that in DC-6s.

The passengers were a typical cross section of northerners fleeing winter at the height of Florida's season. They ranged in age from 18, for Frederick Sweeting, a college student, to 68, for Vice Admiral Edward Orrick McDonnell, retired, proud possessor of a Congressional Medal of Honor.

Also listed on the passenger manifest was Carlos Ramos, a vice president of Havana's Continental Bank. Ramos had been ticketed on a Cuban airline to Havana, but had switched flights.

Not listed on Flight 2511's manifest were Murray G. Edwards of New York City and Mrs. Elizabeth Edwards. Though the Edwardses had been divorced, they wanted to ride to Miami together. They were the last in the long line of passengers who, shortly after 11 p.m., began filing into the Electra. Just ahead of them was a tall, blond man in his early thirties.

When the end of the line reached the mounting stairs, only two of the last three persons could be accommodated.

Edwards was relieved when the tall young man ahead of him stepped aside, saying, "It doesn't matter to me which airplane I take." That left room for both Edwardses in the Electra. The obliging young man who made room for them, a Westport, Conn., attorney named Julian Frank, boarded the DC-6.

The DC-6 had "dense" seating for economy-class passen-

At takeoff the 34 persons had just 2 hours 45½ minutes to live. Except for one man—he had less.



tarily puzzling accident that would soon yield its secret to the painstaking investigative procedures of the Civil Aeronautics Board.

In the next few months, however, it turned out to be one of the most mys-

terious and bizarre episodes in the annals of aviation. This is the story of the crash of National Airlines' Flight 2511—and of the patient scientific detective work that finally unraveled one mystery only to reveal another.

gers, with two seats in each row on the left of the aisle and three on the right, a total of 94. Thus each of the 29 passengers had the luxury of three seats to himself.

Capt. Southard studied the weather reports along his 1,125-mile route to Miami, filed his flight plan, and requested and was granted by Air Route Traffic Control a cruising altitude of 18,000 feet. He estimated his flight time at 4 hours, 45 minutes. This, because of anticipated head winds, was a few minutes slower than schedule time for a DC-6.

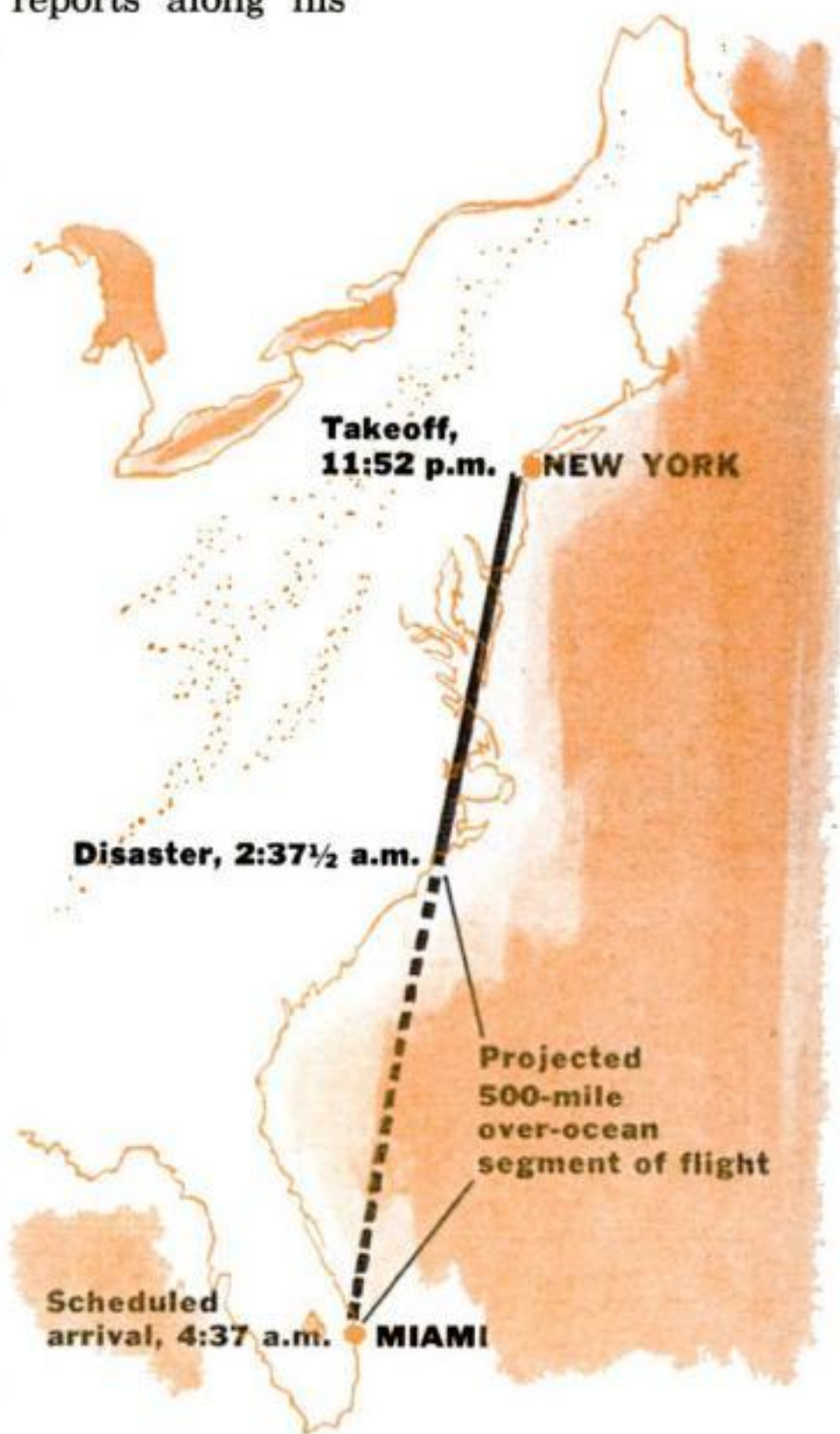
At 26 minutes to midnight the Electra, loaded first and cleared first, lifted off the runway into the night sky. It would land uneventfully in Miami about 3½ hours later.

At eight minutes to midnight Capt. Southard released the brakes on his DC-6 and pushed his four throttles to maximum takeoff power. He had 3,000 gallons of fuel aboard, enough for seven hours. Though the gross weight of the big aircraft thundering down the runway was more than 43 tons, it was still 6½ tons under its legal maximum.

At that moment, he and the 33 persons in his care had just 2 hours and 45½ minutes to live—except for one man. He had less.

CAPT. SOUTHARD climbed out from New York and picked up Victor One, a U. S. airway bound south-southwest. Except for short stretches over Delaware and Chesapeake bays, the airplane would be over land until it was south of Wilmington, N. C. Following normal routine on flights having an over-water leg, the two stewardesses—both blue-eyed blondes—demonstrated to the passengers how to don and inflate their life vests.

As Flight 2511 progressed, the weather worsened. Im-



Intended route: Plane would be over land till south of Wilmington, N.C.



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Close-up shows flight path in final minutes before plane went down 20 miles west of the Cape Fear River at 2:37½ a.m. Wreckage was strewn over a wide area. Apparently the DC-6 had broken apart while still in the air.

mersed in clouds, Capt. Southard had to fly by instruments. Radio talk among pilots of other airliners on the airway reported carburetor icing and storm build-ups. Wind velocities were rising. Southbound planes fell behind their projected flight times.

Capt. Southard progressively radioed his position. At 33 minutes after takeoff, he was still climbing. At one a.m. he leveled off over Salisbury, Md., at his assigned altitude of 18,000 feet. At this height the interior of the plane was pressurized to the equivalent of 6,500 feet. This, though perfectly normal, meant that a pressure differential of 4.16 pounds per square inch was pushing outward on the fuselage shell.

Southard's ground speed up to now, 160 miles an hour, had been slowed both by the wind and the climb. By the time he reached Norfolk, Va., he had improved this to 218 miles an hour. Still, the wind was stronger than he had anticipated.

At 2:13 a.m. Flight 2511 reported that it was over Kinston, N. C., 75 miles short of Wilmington, and was estimating Wilmington at 2:30.

Capt. Sidney L. Oliver, at the controls of a northbound National plane, passed Flight 2511 between Wilmington and Kinston.

"For your information," he recognized the voice of his friend Southard say a moment later to Airway Traffic Control, "2511 broke out in the clear at Wilmington at 18,000." The plane, finally, was

above the clouds and rain.

"Roger," said ATC. "National 2511, contact Jacksonville Center over Drum." Drum was a check point over the Atlantic 63 miles beyond Wilmington.

"Okay," responded Southard, in obvious good humor.

At 2:27 a.m. Flight 2511, just south of Wilmington, reported to National's radio station there. Southard said he was estimating arrival over the Azalea intersection, another ocean check point 131 miles south-southwest of Wilmington, at 3:02. The radio transmission ended at 2:31.

From North Carolina's Cape Lookout to Palm Beach, Fla., the airway's landfall, the Atlantic coastline is a concave curve, a great scimitar, toothed and notched by islands, inlets, and bays. Below Wilmington, Capt. Southard's course took him over a sliver of a north-south inlet called the Cape Fear River.

On the east side of the inlet is a spit of land. Beyond lies the open Atlantic. The inlet is 20 miles long. Its lower reaches on the west side are marshy, tidewater flats.

At Cape Fear, Flight 2511 would start the long, over-ocean leg of the trip, a chord to the great semicircle described by the coastline.

It was now 2:33 a.m. At this instant a terrifying thing happened.

IN THE early-morning hours of January 6, Richard L. Randolph, a farmer living in a new house 1½ miles west of Bolivia and 20 miles west of the Cape Fear River, was awakened by his wife. She had heard a loud noise. Randolph himself heard something that sounded like two explosions. He went to the back door. Wind blew a soft rain in his face. He closed the door and went back to the bedroom and drew back a curtain.

His wife said, "I believe it's going to hit the house."

"No," he said, "ain't no plane going to hit the house."

He was uneasy, but he didn't want to frighten her. They were expecting a child.

Through the window he saw something burning. Then the flame faded. He did hear more noise; but the contractor who had built the house had left some loose tin out in back, and Randolph thought the noise sounded like the wind blowing the tin. He went back to bed.

At daybreak, about 6:30, Randolph sent his son, Macarthur, 14 years old, to his back field to feed the hogs. The boy returned wide-eyed and breathless. A big plane had crashed on the Randolph farm. Randolph ran out to take a look for himself.

Identifying the airline from the wreckage, he ran back to telephone National's office in Wilmington.

THE Civil Aeronautics Board immediately began the kind of investigation that has made its crash-detective work a model the world over. In charge was David L. Thompson, a sandy-haired, middle-aged ex-Navy pilot who flew down to the scene that morning. He and his staff of 10 tramped through the rubble, scattered over fields and woodland, with microphones in their lapels and miniature tape recorders in their pockets. It was faster to dictate than to take notes.

The plane had crashed only minutes after its last radio



Richard L. Randolph, Bolivia, N.C., farmer who reported the disaster by phone—and his son Macarthur, who first spotted the wreck.

General view of crash scene shows pathetic mass of rubble that was once a proud airplane. Impact was so severe that some of the engines were driven six feet into ground.



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report—the clock on Capt. Southard's instrument panel had been smashed at 2:37½ a.m.

But it was a crash fitting no ordinary pattern. Most of the wreckage was scattered in bits and pieces over a three-quarter-mile area.

Seemingly the plane had broken into three huge pieces and countless smaller ones while still high in the air. The wreckage had fallen from a considerable height. Some of the engines had dug holes in the ground four to six feet deep.

The bodies of seven of the passengers were found clad in life jackets.

And 16 miles to the southeast by the marshes and beaches near the mouth of the Cape Fear inlet, there were reports of more wreckage that had fallen from the sky the night before.

Marine and National Guard troops, some of them skin divers, combed the inlet and a corridor from the inlet to the crash site for debris. Hall Watters, a local charter pilot, searched the inlet in a Piper Cub.

At Wilmington Airport, the investigators built a mock-up of the fuselage, of wood and chickenwire, and on it was hung what remained of the plane. That complicated the puzzle—a sizable section of the skin and fuselage structure on the right side, over the wing, was missing. The missing portion, constituting a fifth of the entire fuselage surface, was roughly triangular, running from the leading to the trailing edge of the right wing and extending upward beyond the parcel rack.

For a working hypothesis, investigators wondered if not one but *two* separate disasters could have overtaken the aircraft. One might have disabled it high over the Cape Fear inlet. Then Capt. Southard, struggling for control, might have reversed course and flown back for 16 miles before his broken plane disintegrated in the air.

But what could have been the cause?

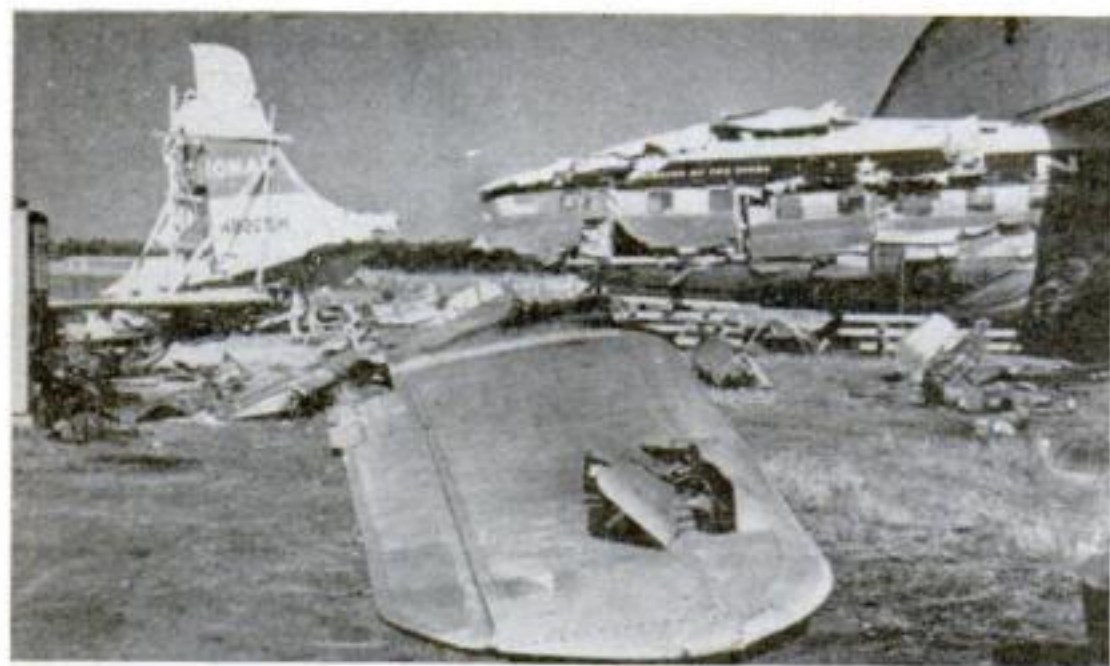
Thompson methodically considered the possibilities:

- Metal fatigue, leading to explosive rupturing of the pressurized fuselage. But a study of the aluminum structural members showed no telltale, progressive rings, light in hue, that would indicate a gradual weakening of the metal.

- A broken prop blade knifing through the fuselage, followed by explosive decompression. But all 12 blades were found in place on their hubs.

- A failure of the cabin pressurization-relief valves. But the valves were found perfect.

The silence of death hovers over a portion of the wreckage as one of the plane's crew of five lies buried in twisted debris.



At Wilmington, CAB experts built mock-up and hung on it what remained of shattered fuselage.

- Collision with something in the air. But there were no paint smears, dents, or striations that would be left by an object heavy enough to inflict mortal wounds on so big a plane.

- A lightning stroke. No tiny pools of metal-melt, flash-heated—nor the characteristic pitting that would be distributed over wings and fuselage—were found.

- A fuel-vapor explosion. When fuel explodes, the wings—the containers—bulge, and seams are forced open. The metal stretches. That had not happened. Clean fractures showed that the damage to the wings had been caused when they hit the ground.

- An oxygen-bottle explosion. Planes like the DC-6 typically carry a few emergency tanks of compressed oxygen. But a break would give such a bottle a jet-propelled impulse of only 56 pounds, far too little to wreak the damage done.

- And finally, detonation of a “foreign” explosive brought inside the cabin. No evidence of that had been turned up.

The mystery deepened. Engines and propellers had been working normally right up to the instant of the airplane's final breakup. That was determined by standard procedures:

At cruising altitudes the DC-6 propellers turn at constant speed. Only their blade pitch changes. The propeller governor racks showed that the engines were developing a normal 1,000 horsepower, each at 2,200 r. p. m. when they hit the ground.

Propeller blade angles were examined. There are brass shims on blade shanks. On impact, a shoulder on the hub assembly almost always dents the shim plates. Since the shims are indexed to the blades, the blade angle at impact can be read off the dents with a special protractor. The blade angles had been at 50 degrees, in cruising range.

Three of the engines showed no fire damage. The two on the left had stayed with their wing all the way to the ground. The outboard engine on the right had torn free of its wing in the mid-air breakup. Two breaks had been made in the firewall of the inboard engine on the right wing. Fire had tongued through those holes and consumed most of the engine rear section behind the cam compartment. But the experienced crash detectives knew that this must have happened on the ground. If it had burned in the air, the slipstream would have brushed on horizontal soot patterns and melted-metal flowbacks.

None of the fuel tanks had caught fire.

Yet whatever had happened at 3½ miles above the Cape Fear River, the forces involved in the disaster had been savage.

Part of the fuselage had been torn as though by a mammoth, old-fashioned can opener. The tears were not the characteristic breaks caused by ground impact. Careful study showed that many of them had been made by some severed electrical cables. Whipped angrily by the plane's speed, the armored wires had flailed through fuselage structure and skin.

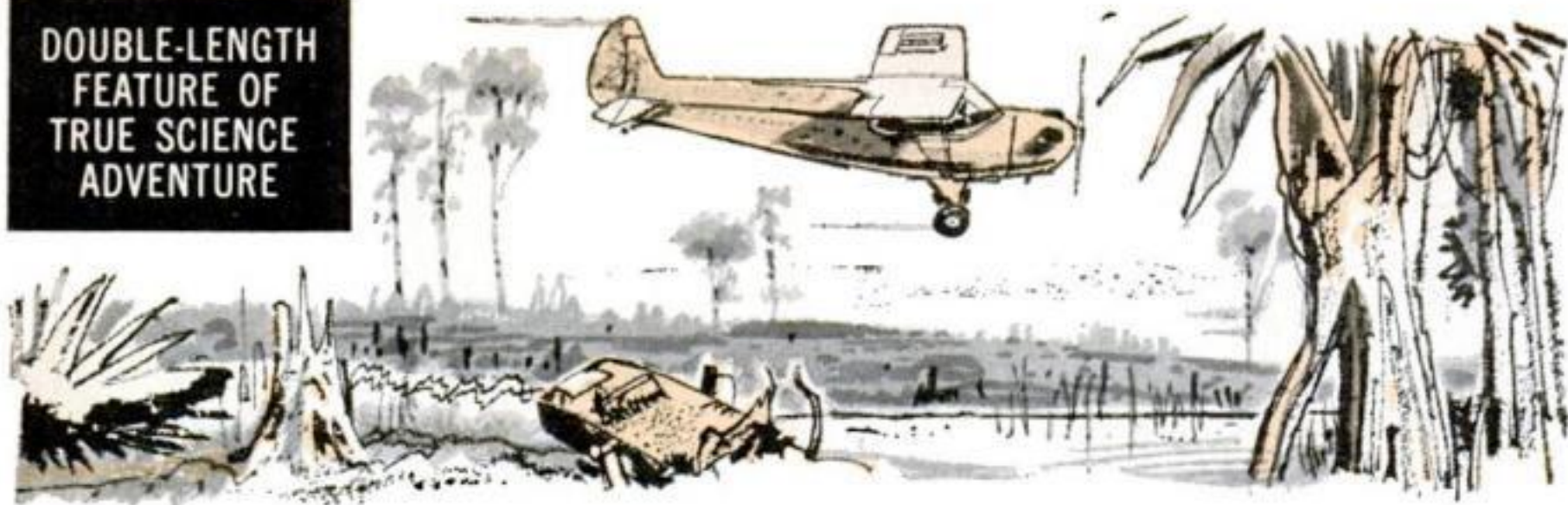


Detail photo shows interior of main cabin mock-up on right side, just forward of seat No. 7.



Parts of tail section are hoisted into position and tacked on by workmen during reconstruction.

DOUBLE-LENGTH
FEATURE OF
TRUE SCIENCE
ADVENTURE



Three days after crash, Hall Watters—a local charter pilot flying a Piper Cub—spotted Frank's body as he flew over Snow's Marsh, 15 miles from main crash site.



The forward fuselage on the right side also bore 13 vertical, staggered cuts. These were jagged, like the edge of a piece of plywood run through a coarse-tooth table saw. This suggested that part of the fuselage had somehow swung into the right inboard prop. Fuselage paint on two of the three blades of this prop sustained that conclusion.

This had evidently occurred *before* final disintegration of the stricken plane, because the starboard engines had wrenched free of their wing at the very start of the breakup. In the wreckage plot of the Cape Bolivia area, they had been found back along the flight path, almost 4,000 feet from the port engines.

Now the bits and pieces of the puzzle began accumulating faster. Thirty-two of the 34 bodies had been found almost immediately. One of the two missing was that of Cuban banker Carlos Ramos; the other was that of young lawyer Julian Frank.

On Saturday, January 9, Pilot Watters in his Piper Cub located Frank's shattered body on Snow's Marsh, on the west side of the Cape Fear River, almost 15 air miles from the main crash site. It obviously had been catapulted from the aircraft. Watters also spotted a plane's three-seat unit.

On January 14, the body of Carlos Ramos was discovered at the site of the main wreckage.

Other debris that turned up at the inlet in the vicinity of Frank's body began to intrigue the investigators. There were remnants of a blue nylon passenger's flight bag that closed with a zipper. A life jacket had zipper teeth embedded in it, and was impregnated with blue nylon fibers. Other pieces of a blue flight bag were combed from the torn interior of the main wreckage.

Now all the resources of scientific research were marshaled. Hundreds of bits of metal, cloth, and human flesh were subjected to spectrographic, X-ray, microscopic, and chemical analysis. The laboratories engaged included those of the Federal Bureau of Investigation, New York City's chief medical examiner, the Armed Forces Institute of Pathology, and the Civil Air Surgeon's office.

A "human factors" group of 11 men was formed to evaluate the findings. Represented on it were the CAB, the Army, Navy, and Air Force, the Federal Aviation Agency, the Douglas Aircraft Co., National Airlines, Eastern Air Lines, and the Airline Pilots Association.

Chemical analysis showed that the life jacket found near Frank's body contained nitrate residues. Sodium carbonate,

sodium nitrate, and sodium sulfur compounds were found in one of the cabin air vents. Numerous small pieces of wire, less than 1/32 of an inch in diameter, were scattered in the fuselage opposite the point where structure and skin were missing. All of them had been "necked down" at the ends by tremendous tension.

Particles from a flight bag and traces of manganese dioxide had embedded themselves in the plane's carpeting.

The body of Julian Frank also began yielding clues.

The upholstery on the underside of seat No. 7—part of the unit found near Frank's body—was shredded, and the tubular framework distorted. An imprint on Frank's hips proved to be from the fabric pattern of seat No. 7.

Both of Frank's legs had been severed below the knees. The bones were shattered. The injury patterns of more than 1,400 persons who had fallen or jumped from airplanes were culled from the files of the Aerospace Pathology Branch of the Armed Forces Institute. All those bone breaks had been neat, as though made by a surgeon's saw. Nobody else on Flight 2511 had sustained injuries like Frank's.

A piece of brass was removed from Frank's left arm. Another piece of brass had adhered to one of his severed legs—found inside a piece of his trousers and lodged in a port-side parcel rack in the main wreckage. From Frank's right wrist some of the tiny, necked-down wires were removed by tweezers.

But it was on Frank's hands that laboratory interest focused.

Granular particles removed from his right hand were studied by spectroscope, an instrument that interprets materials by their color values. The particles looked like carbon black by diffused light and held a grayish sheen by reflected light. The hand also contained deposits of manganese dioxide. None of this was found in the body of any other passenger.

Some of the fingers of Frank's left hand were missing, and the wounds were ragged and shattered, like those on his legs.

The Civil Aeronautics Board called a formal hearing on the case of National Flight 2511 on March 22. It fitted together the fragments of evidence:

Sodium carbonate, sodium nitrate, and sodium-sulfur compounds—ran the testimony—were typical residues of a dynamite explosion.

The tiny pieces of wire, necked down, were typical of what happens to wire used to bind together sticks of dynamite.

The manganese dioxide was from a dry-cell battery that apparently had been used to detonate the dynamite. This battery must have been carried aboard: While the plane



This life jacket, found at Kure Beach, 16 miles east of Bolivia, showed traces of nitrate, substantiating theory that an explosive was set off in the passenger cabin.



Plane's three-seat unit—recovered from Snow's Marsh near spot where Pilot Watters found Frank's body.

had its own emergency dry cells, all had been recovered.

The dispassionate eye of the laboratory technician was cast in the direction of the passenger Julian Frank.

"Do you find," Dr. Frederick W. Lovell of the Armed Forces Institute was asked at the hearing, "that the amputa-

Was it suicide—or murder?



Had Julian Frank callously killed himself and 33 innocent people by exploding dynamite under seat No. 7? The evidence seemed to scale heavily toward that theory...



... But could he instead have been the victim of murder? Could an identical flight bag, containing dynamite and a time clock, have been switched for his own at Idlewild?

SIX months and six days after Flight 2511 had fallen in pieces from the night sky, the CAB issued its report. Qualified cautiously, as always, it said: "The Board determines that the probable cause of this accident was the detonation of dynamite within the passenger cabin."

Who touched off the dynamite? That was not for the board to say. The malicious destruction of an aircraft is a federal crime, the FBI's province. For more than a year that agency has worked on the case, at times with as many as 100 agents.

But the CAB's crash detectives can now describe the events in the disaster with precision. The dynamite blast had torn out a big triangle of structure and skin, just above the right wing root. The pressurized cabin air swirled out like a tornado, and the thin, bitter-cold outside air filled the plane. The airliner's nose pitched downward. It began a great circle to the right, descending at thousands of feet a minute, far beyond its design limits. Severed cables flailed at the torn fuselage. Some of the terrified passengers snatched at life jackets.

For perhaps three minutes the plane plunged at its steep, curving glide through the clouds, its speed building higher and higher. Sixteen miles from the point of explosion, the tortured right wing broke off, the fuselage shattered, and Flight 2511 fell in fragments to the ground. A fire bloomed and crackled. Then it went out, and darkness and silence enveloped the rain-soaked mass grave.

What human hand had rent Flight 2511 asunder?

Julian Andrew Frank, 33, the tall young man who had given up his seat in the Electra so that the Edwardses could ride to Miami together, was known to have carried a blue, zippered flight bag aboard Flight 2511. Exceptionally heavy for a small bag, it had weighed 20 pounds at National's check-in counter.

Newspapers began fitting additional pieces into the jigsaw puzzle. Less than a year before, Frank had taken out more than \$1,000,000 in life-insurance and accident policies.

The skein of Frank's business activities was tangled and dark. Suit had been filed against him charging misappropriation of \$20,000. A district attorney had received a complaint that Frank had failed to account for money turned over to him as an advance on a fee. Still another attorney said Frank had asked him to represent him in disbarment proceedings.

Had Julian Frank killed himself and 33 others by exploding dynamite under seat No. 7? The evidence that scaled so heavily toward that theory had its counterweights:

- Close friends agreed that while Frank was moody and unpredictable, he was not suicidal.
- Frank's insurance policies contained the usual suicide

10-10-10

10-10-10

This One



D7X9-N3W-UUS9

tions in this case were caused by an explosive blast?"

"Yes, sir," said the witness.

The piece of brass removed from Frank's left arm was like that from a clip-type dry battery. The piece from his leg had formed the front retainer plate of a travel alarm clock.

clause. As a lawyer, he would have known well that if suicide occurred—and was identified—so soon after the policies were written, the money would not be paid. (At this time, it has still not been paid—pending final settlement in the courts.)

- An unsigned insurance application for an additional \$200,000 was found among Frank's papers.

- Frank had rejected a double-indemnity provision, in case of accidental death, on part of his insurance.

- If suicide-bent, why did Frank bother to buy a round-trip ticket, or plan a trip to Argentina within a week?

Or could all of this have been only a shrewd "cover" for a shockingly callous crime? Had Julian Frank, at 2:33 on that stormy night, believed that Flight 2511 was so far out over the ocean that its fragments could never be recovered and analyzed?

Or could Julian Frank have been murdered? Could an identical flight bag, containing the dynamite and a time clock, have been switched for his own in the confusion at the airport by someone intent on destroying him?

These are not questions that can be answered by spectroscopy and X-ray. Some light can be cast on them, however, by circumstantial speculation:

1. At 2:33 the original jet flight, had it not been canceled, would already have been on the ground in Miami for half an hour. So the clock in that blue flight bag must have been set after it became known that Frank would take one or the other of the substitute planes.

2. At 2:33 the substitute Electra flight was off the mid-coast Florida shore, almost 50 miles from land, where the ocean depths were 1,400 feet.

3. At 2:33 the substitute DC-6 flight would also have been out over the Atlantic—if it had not been slowed by head winds.

If someone else had set the clock and planted it on Frank, the murderer would have had to be at the airport—to know that the jet flight was canceled, to make hasty calculations on the differing flight times of the Electra and the DC-6, and to reset the clock before substituting the bag.

But if Frank himself set the clock, wouldn't he have known that the plane was not yet out over the Atlantic at 2:33? Not necessarily. A passenger flying at 18,000 feet at night over layered undercast could not know whether the plane was over land or ocean.

But why a clock? A bomb in the hands of the bomber needs no timing mechanism. A simple switch will do.

Or, considering the terrible anxieties of a suicide aboard an airliner, would a man determined to kill himself have calculated that it would be surer if he did not leave the agonizing final decision to human will?



In 1955, Julian Andrew Frank, young Westport, Conn., attorney, married a pretty model named Janet Wagner. No hint of tragedy marred their wedding portrait.

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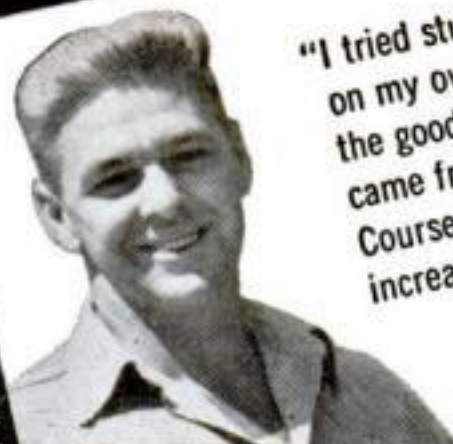
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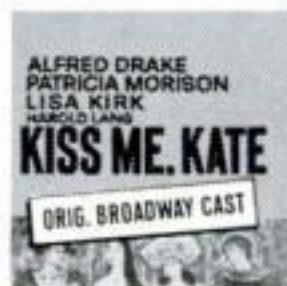
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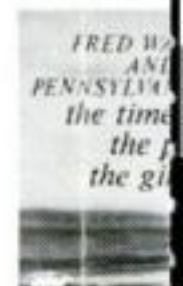
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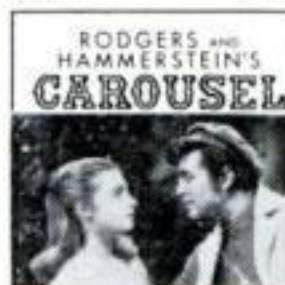
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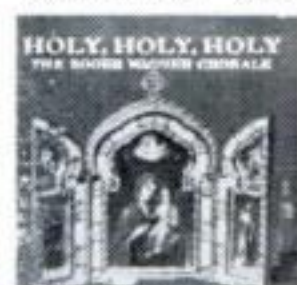
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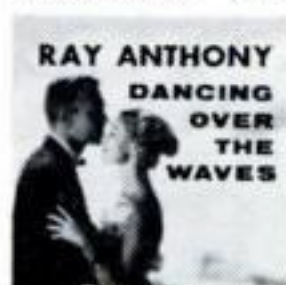
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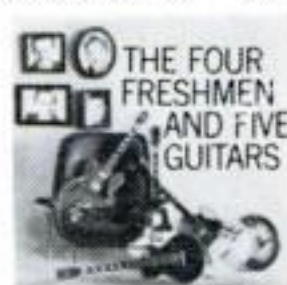
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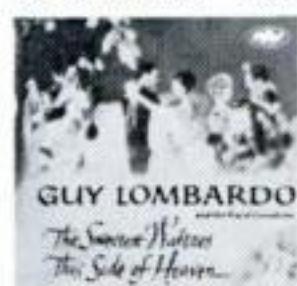
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